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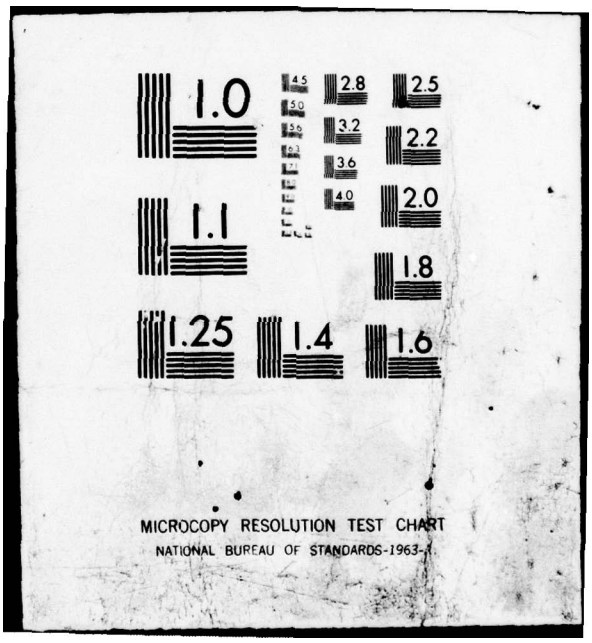
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CLOVE BROOK, SUSSEX COUNTY
NEW JERSEY

LEVEL II

CLOVE RIVER DAM
NJ 00035

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Clove River Dam (NJ-00035). Hudson River Basin, Clove Brook, Sussex County, New Jersey. Phase 1 Inspection report.

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(10) Anthony G. /Posch

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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Spillways
Outlet works
Visual inspection
Structural Analysis
National Dam Inspection Act Report

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Clove River Dam in Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Clove River Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate since 57 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of observation wells or piezometers to facilitate seepage studies. A study should also be undertaken regarding the removal or blocking of the auxiliary spillway and the reconstruction of the downstream area. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Within three months from the date of approval of this report, the existing dam drawings should be annotated and updated to form a coherent as-built set.

d. The following remedial actions should be completed within six months from the date of approval of this report:

(1) All brush and trees should be removed from the crest and the downstream and upstream slopes to avoid problems which may develop from roots. The embankment faces should then be seeded to develop a growth of grass for surface erosion protection.

(2) Repair all cracked and spalled concrete with epoxy cement.

(3) Provide slope protection on the right bank of the downstream channel, at the toe of the spillway.

(4) Restore the low-level outlet's operating mechanism and access platform.

e. The following remedial actions should be completed within one year from the date of approval of this report:

(1) Regrade the crest of the embankment to restore vertical alignment above the top of the concrete core wall.

(2) Remove the dead trees from the downstream channel, and the abandoned farm bridge's concrete abutments and central pier located about 100 yards downstream to prevent clogging.

(3) Consider providing additional low-level outlet facilities.

(4) A formalized program of annual inspections of the dam should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be read during severe rainstorms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance visits to the dam, the lake and the outlet passages. Movement and settlement of the structures should be monitored regularly by means of surveying monuments, and any seepage flows recorded.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James A. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

CLOVE RIVER DAM (NJ00035)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 7 May 1979 by Frederic R. Harris, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Clove River Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate since 57 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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c. Within three months from the date of approval of this report, the existing dam drawings should be annotated and updated to form a coherent as-built set.

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(1) All brush and trees should be removed from the crest and the downstream and upstream slopes to avoid problems which may develop from roots. The embankment faces should then be seeded to develop a growth of grass for surface erosion protection.

(2) Repair all cracked and spalled concrete with epoxy cement.

(3) Provide slope protection on the right bank of the downstream channel, at the toe of the spillway.

(4) Restore the low-level outlet's operating mechanism and access platform.

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(1) Regrade the crest of the embankment to restore vertical alignment above the top of the concrete core wall.

(2) Remove the dead trees from the downstream channel, and the abandoned farm bridge's concrete abutments and central pier located about 100 yards downstream to prevent clogging.

(3) Consider providing additional low-level outlet facilities.

(4) A formalized program of annual inspections of the dam should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be read during severe rainstorms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance visits to the dam, the lake and the outlet passages. Movement and settlement of the structures should be monitored regularly by means of surveying monuments, and any seepage flows recorded.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 22 Sep 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Clove River Dam, I.D. NJ00035

State Located: New Jersey

County Located: Sussex County

Stream: Clove Brook, Tributary to Papakating Creek

Date of Inspection: May 7, 1979

Assessment of General Condition

Clove River Dam is an earthfill embankment approximately 300 feet long and 28 feet high, and has an 81 foot long ungated concrete ogee spillway. The general condition of Clove River Dam appears good. The dam embankments were well constructed and have not undergone significant surface deterioration. The spillway structure has some minor spalling on the wingwalls and ogee, but is in good overall alignment. There is considerable tree and brush growth on the embankment faces and crest. The hazard potential is rated as "high."

The safety of Clove River Dam is considered questionable in view of its lack of spillway capacity to pass one-half the PMF without overtopping the dam. The spillway is capable of passing a flood equal to 28 percent of the PMF, and is rated "inadequate."

At present, the engineering data available is not sufficient to make a definitive statement on the stability of the dam.

The following actions, therefore, are recommended along with a timetable for their completion. All recommended studies should be conducted by an engineer qualified in the design and construction of dams.

1. The existing drawing of the dam should be annotated and updated to form a coherent as-built set, within three months.

2. Carry out a more precise hydrologic and hydraulic analysis of the dam within six (6) months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop alternative schemes for construction. This should include the installation of headwater and tailwater gages.

3. Install observation wells or piezometers in the downstream embankment, and log the borings to determine engineering properties of the dam fill and foundation material. This program and a stability analysis based on the findings should be completed within twelve months.

4. Carry out remedial measures to the dam structure within six months including repair of all spalled concrete with epoxy cement; provision of surface protection to the right downstream face.

5. Restore the low-level outlet's operating mechanism and access platform. This work is to be done within six months.

6. Establish a flood warning system for the downstream community within three months.

7. Remove trees and vegetation from the embankment and seed exposed faces with grass within 12 months.

Furthermore, while of a less urgent nature, the following additional action is recommended and should be carried out within a reasonable period of time.

1. A program should be developed to monitor the seepage through and under the dam. Depending on the information provided, the need for corrective measures can be considered and, if necessary, undertaken.

2. A program of annual inspection and maintenance should be initiated. This should include lowering the lake, and updating the operation and maintenance log. Movement and settlement of the embankment should also be monitored by means of surveying monuments.

3. Regrade the crest of the embankment to restore vertical alignment above the top of the concrete core wall.

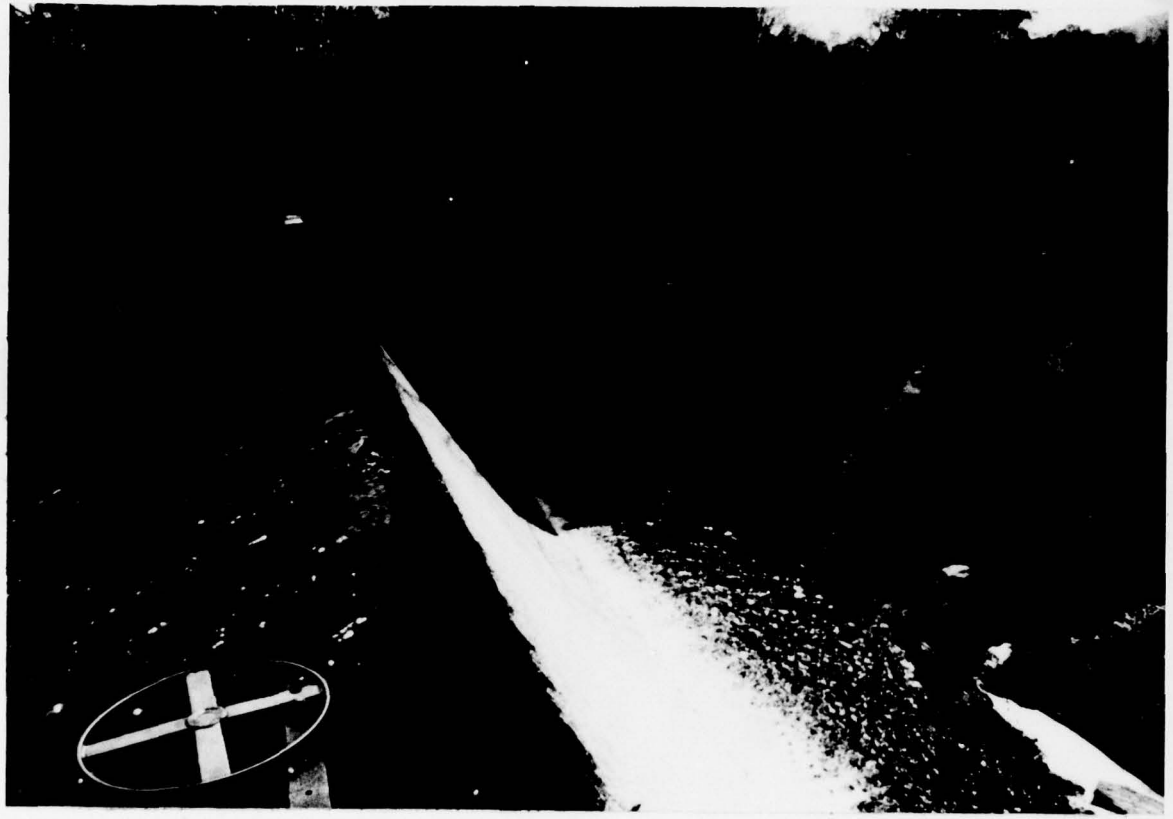
4. Provision of additional low-level outlet facilities should be considered.

5. Remove the dead trees lying on the downstream channel, and the abandoned farm bridge's concrete abutments and central pier located about 100 yards downstream, to avoid clogging the channel with trees and debris during a storm, and possible toppling of the piers into the stream, local flooding, and bank erosion.

A. G. Posch

Anthony G. Posch, P.E.

AGP/REG:cc



Clove River Dam
Overall view of dam from the right.

May 7, 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

CLOVE RIVER DAM, I.D. NJ00035

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn, is contracted to the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Clove River Dam was made on May 7, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

1.2 Description of Project

a. Description of Dam and Appurtenances

Clove River Dam is an earthfill embankment approximately 300 feet long and 28 feet high, with a concrete corewall. There is an 81 foot wide concrete ogee spillway structure towards the right of the dam, fitted with triangular shaped concrete wingwalls. The dam is built on top of a thin layer of glacial till founded on bedrock (Martinsburg Shale).

The low-level outlet consists of a 3' wide by 4' high rectangular conduit through the bottom right corner of the spillway. At the

upstream end, the conduit reduces to a 3' square section, and closure is provided by a sluice gate. The guides and a manually operated gate mechanism are at the upstream face of the spillway. At present, the sluice gate is in the closed position and its operating mechanism is inoperable, and perhaps damaged. There is an access platform of steel supports with a timber deck fixed to the right wingwall.

The embankment extends approximately 150 feet to the left of the spillway and 42 feet to the right. The embankment and wingwalls have a slope of 2H:1V on both faces, as shown in the original drawing. Rip-rap protection has been provided to the upstream face of the embankment.

Clove Brook, immediately downstream of the dam, traverses a narrow flat valley, and enters the wide flood plain of Papakating Creek about 1/2 mile downstream, passing under two road-bridges before the flood plain.

b. Location

Clove River Dam is located in the Borough of Sussex, Sussex County, New Jersey. It is reached by way of Elizabeth Avenue off Route No. 565.

c. Size and Hazard Classification

Clove River Dam has a structural height of 28 feet and a reservoir storage of 472 acre-feet. Since its storage is less than 1,000 acre-feet and its height is less than 40 feet, it is classified in the dam size category as being "small." A hazard potential classification of "high" has been assigned to the dam on the basis that failure would result in excessive damage to the two roads and bridges below the dam and to downstream property, including a farm and three houses. The possibility also exists of the loss of more than a few lives in the event of dam failure.

d. Ownership

Clove River Dam is presently owned by the Borough of Sussex due to a foreclosure in 1948. The former owners had been Clove Acres Lake Development Co.; the builders of the present dam and spillway.

Mayor & Common Council
Borough of Sussex
2 Main Street
Sussex, NJ 07461
(201) 875-4831

e. Purpose of Dam

Clove River Dam was built to provide a lake for realty development and recreation. It serves no other purpose.

f. Design and Construction History

The present dam was designed in 1928 and built in 1929-30. The Water Policy Commission, Trenton, New Jersey coordinated and approved the design and construction of the dam. Permission to build the dam was also granted by the Department of Conservation and Development.

The final report, written by an engineer from the Water Policy Commission, was made in 1932 to recommend acceptance of the dam.

The last inspection was made on October 10, 1968. This inspection revealed slight spalling on the wingwalls, slight seepage at the toe of the right embankment, and the already inoperable condition of the outlet gate.

g. Normal Operating Procedures

The discharge from the lake is over the concrete ogee spillway, which is unregulated. The low-level outlet was not used on a regular basis. It was opened occasionally, for inspection purposes, until it fell into disrepair. No known regular maintenance is conducted on the dam.

1.3 Pertinent Data

a. Drainage Area	22.4 square miles
b. Discharge at Dam Site	
Maximum known flood at dam site:	Not above top of dam.
Ungated spillway capacity at elevation of top of dam:	7,628 cfs (elev. 431.5' MSL)
Total spillway capacity at maximum pool elevation:	13,704 cfs (elev. 434.04' MSL)
c. Elevation (Feet above MSL)	
Top of dam:	431.5'
Maximum pool design surcharge: (SDF)	434.04'
Spillway crest:	423.0'

Low-level outlet (invert):	406'
Streambed at centerline of dam:	404'
Maximum tailwater:	412' (estimate)

d. Reservoir

Length of maximum pool:	3,500 ± feet (estimate)
Length of recreation pool:	2,700 ± feet (estimate)

e. Storage (Acre-Feet)

Recreation pool:	133
Top of dam:	472
Maximum pool:	633

f. Reservoir Surface (Acres)

Recreation pool:	24.7
Top of dam:	57 (estimated)

g. Dam

Type:	Earth fill, concrete spillway.
Length:	300'
Height:	28'
Top width:	20'
Side slopes - Upstream:	2H:1V
- Downstream:	2H:1V
Zoning:	Unknown.
Impervious core:	Concrete core wall.
Cutoff:	None.
Grout curtain:	None.

h. Diversion and Regulating Tunnel

N/A

i. Spillway

Type:	Dropped concrete ogee.
Length of weir:	81 feet (net)
Crest elevation:	423.0' MSL
Gates:	N/A
U/S Channel:	None.
D/S Channel:	Channel with natural rock bottom to Clove Brook.

j. Regulating Outlets

Low level outlet:	Rectangular 3' x 4' conduit with 3 feet square entrance.
Controls:	Hand-operated sluice gate.
Emergency gate:	None.
Outlet:	None.

SECTION 2: ENGINEERING DATA

2.1 Design

No design computations for the dam are available. A drawing dated June 11, 1930 gives the plan, elevation and sections of the dam and outlet structures (spillway, discharge channel and low-level outlet conduit). No data from soil borings, soil tests or other geotechnical tests are available. Reports by the inspector from the Water Policy Commission, Trenton, New Jersey, during the core wall construction, state that the east core wall is founded in a dense yellow fill, except for the last ten feet, which is in blue clay; and the west core wall is founded directly on solid slate bedrock.

2.2 Construction

The construction history is presented in Section 1.2.f. No data exist of borrow sources, but the engineers' inspection and progress reports during construction of the concrete core walls, wingwalls and spillway in 1930 are available from NJDEP.

2.3 Operation

Operation of the outlet sluice gate was discontinued before 1968. An inspection in the aforementioned year, revealed the gate mechanism was inoperable.

2.4 Evaluation

a. Availability

The availability of engineering data is poor. The stated drawing and some correspondence on the dam are available from the NJDEP.

b. Adequacy

The engineering data available, together with that obtained in the field, were adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform even approximate computations of the embankment's stability, but preliminary evaluation could be made based on visual observation.

c. Validity

Validity was assessed by visual inspection and by limited measurement in the field. The present spillway and embankment structures, and low-level conduit are as shown on the design drawing. The sluice gate and its operating mechanism, and access platform, are not shown in the drawing. The drawing only indicates that such items are to be provided, subject to approval by the engineer. All other engineering data was found to be valid.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection made of Clove River Dam revealed that the dam and spillway were in a good condition, but that some repairs followed by a regular program of inspection and maintenance are required. The lake level was above the spillway crest at the time of inspection.

b. Dam

The dam embankment appears to be stable. The downstream and upstream faces have a 2H:1V slope. No cracking is visible anywhere on the embankment, and no horizontal misalignment has been noted.

Minor seepage was observed at two places: one on the right embankment immediately downstream of the right wingwall, and the the other about five feet downstream, on the right bank. Both were estimated at 1/2 gallon per minute.

Some vertical misalignment was visible along the crest, exposing the top of the concrete core wall in some places. Trees up to 10 inches in diameter and brush are growing profusely on both faces and crest of the left and right embankments. No evidence of animal burrowing was found. No riprap failure were noted.

c. Appurtenant Structures

1. Spillway

The concrete spillway shows some signs of surface weathering, and some spalling and minor seepage in the wingwalls, but the flow of water over the spillway was smooth, indicating good alignment.

2. Discharge Channel

The discharge channel was a natural rock bottom with side slopes of about 1.5H:1V, except on the right bank at the toe of the spillway, where the bank has eroded to a nearly vertical slope.

3. Low-Level Outlet

A rectangular conduit 4' high and 3' wide, with its invert at the level of the spillway toe, is constricted at its intake end

to a 3 ft. square section. The outlet is located at the lower right corner of the spillway and discharges at the spillway toe. Closure is provided by a sluice gate, now inoperable, from the operating platform, where the manually operated wheel is located. The platform has steel supporting brackets fixed to the right wingwall. The timber platform deck is completely deteriorated and unusable.

d. Reservoir Area

The slopes around the rim of the reservoir are moderate. They are grassed and wooded with deciduous trees. Residential development extends around the entire lake. There is no indication of slope instability. Sedimentation has occurred in part of the reservoir and about 5 feet of silt was measured at the dam's upstream face.

e. Downstream Channel

The downstream channel is shallow beyond the spillway apron and some fallen trees are lying in the stream. The channel is about 40 feet wide and is well defined. Banks are sloped at about 1.5H:1V; the left bank being 8 to 10 feet high with a pasture at the top, and the right bank being approximately 25 feet high with Elizabeth Avenue running along the top. Both banks have a heavy cover of trees, some of which are sloping down, indicating instability. Two small areas of seepage were noted in the right channel bank near the toe of the spillway. About 100 yards downstream are the concrete abutments and centerspan pier of a bridge, now without a deck. The stream passes under road bridges at Newton Avenue and Loomis Avenue within 1,500 feet of the dam. There are three inhabited residential buildings in the flood-path before the first road embankment. About 1/2 mile downstream, the valley widens to meet the wide and flat flood plain of Papakating Creek.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Clove River Dam is used to impound water for recreational purposes. The discharge from the lake is normally over the ungated ogee spillway. A gated, 3 foot square outlet located on the right side of the spillway has been used to lower or empty the lake. Before 1968, this outlet was opened occasionally for inspection purposes. An inspection in 1968 revealed that the sluice gate was no longer operable.

4.2 Maintenance of the Dam

There is no program of regular inspection and maintenance of the dam and appurtenant structures. The present owners have only performed minimal maintenance on the dam, although they are responsible for this function. No records were uncovered of any maintenance since construction.

4.3 Maintenance of Operating Facilities

The operating facilities of the dam consist only of the sluice gate at the upstream end of the outlet conduit. This gate has not been maintained since some time before 1968.

4.4 Evaluation

The present procedures are not conducive to satisfactory operation of the dam. The level of maintenance is fair only, and should be amended by implementing a program of regular inspection and maintenance.

It was good practice to lower the lake level for inspection, and the ability to carry out this function should be reinstated.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The drainage area above Clove River Dam is approximately 22.4 square miles. A drainage map of the watershed of the dam site is presented on Plate 1, Appendix D.

The topography within the basin is moderately to steeply sloped. Elevations range from approximately 1,200 feet above MSL at the north end of the watershed to about 435 feet at the dam site. Land use patterns within the watershed are mostly woodland with concentrated residential development about the lake area.

The evaluation of the hydraulic and hydrologic features of the dam and lake was based on criteria set forth in the Corps Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The Spillway Design Flood (SDF) for the dam falls in a range of 1/2 PMF to PMF. In this case, the low end of the range, 1/2 PMF is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The probable maximum flood (PMF) was calculated from the probable maximum precipitation using Hydrometeorological Report No. 33 with standard reduction factors.

The unit hydrograph was determined by Snyder's Method. Snyder's peaking coefficient Cp was specified by the Corps of Engineers as 0.62. The synthetic unit hydrograph was developed with the HEC1-DB program.

Initial and infiltration loss rates were applied to the Probable Maximum Precipitation to obtain rainfall excesses. The rainfall excesses were applied to the unit hydrographs to obtain the PMF and various ratios of PMF utilizing program HEC1-DB.

The SDF peak inflow calculated for the dam is 13,704 cfs. This value is derived from the 1/2 PMF, and results in overtopping of the dam, assuming that the lake was originally at the spillway crest elevation.

The stage-outflow relation for the spillway was determined from the geometry of the spillway and dam, and is shown in the Hydrologic Computations (Appendix D).

The reservoir stage-storage capacity relationship was computed directly by the conic method, utilizing the HEC1-DB program. The conic method assumes that the reservoir capacity resembles a series of vertically stacked cones. The reservoir surface areas at various elevations were measured by planimeter from a U.S.G.S. Quadrangle topographic map. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve was based on the assumption that the dam remains intact during routing.

A breach analysis indicates that the hazard potential for loss of life downstream, due to dam failure from overtopping, is not appreciably greater that that which exists without failure, and therefore, the spillway is assessed as "inadequate."

Drawdown calculations indicate that if the 3'x3' square low-level outlet were restored to working order, the reservoir could be lowered to an elevation of 410' MSL within a period of 24 hours, assuming a 2 cfs/square mile inflow. This is not considered an adequate time-frame for drawdown, and additional outlet facilities are recommended.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. Nobody questioned could recall the dam being overtopped in its history, but the tailwater has risen above the 8-foot high left bank on occasions.

c. Visual Observation

The valley immediately below the dam is developed and grassed. One-half mile downstream, the channel enters a wide flood plain. The slopes of the reservoir are mild and do not exhibit signs of instability. The drainage area is wooded, moderately to steeply sloped and partly developed for residential use.

d. Overtopping Potential

A storm of magnitude equivalent to the SDF would cause overtopping of the dam to a height of 2.54 feet. Computations indicate that the dam can pass approximately 28 percent of the PMF without overtopping the dam crest. Since one-half the PMS is the Spillway Design Flood (SDF) for this dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps of Engineers, the spillway capacity of the dam is assessed as "inadequate."

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The observations made during the inspection do not give cause for concern. However, the excessive growth of large trees and brush on the embankments may damage the embankments, their rip-rap, and the concrete wingwalls. In addition, the wingwalls are spalled at their intersections with the spillway and some spalling is also visible on their downstream faces, as well as on the surface of the spillway. The siltation of the reservoir has reduced its capacity, but the banks are stable. No major misalignment was noted to suggest instability. The present exposure of the top of the core wall in some places may be due to further compaction or settlement of the material along the crest of the embankment. The steep slope on the right channel bank requires erosion protection.

b. Design and Construction Data

Some design computations were uncovered during the report preparation phase. These were approximate computations of spillway stability and spillway discharge. No embankment or foundation soil parameters are available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction are available for use in the stability analysis. However, the one drawing of the dam provides good data on dam cross sections.

c. Operation Records

No operating records are available relating to the stability of the dam.

d. Post-Construction Changes

No changes significant to the stability of the dam are on record.

e. Static Stability

A static stability analysis was not performed for the embankment because the lack of data on which to base assumptions of material properties and embankment cross sections might produce misleading results. The recommended remedial actions must be implemented in order to decrease the risk of local failure, but the static stability of the embankment appears, by inspection, to be adequate.

An approximate stability analysis of the concrete spillway indicates the spillway structure will be stable during a Spillway Design Flood (SDF).

f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers. In general, projects located in Seismic Zone 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. The last two conditions appear to be fulfilled and the seismic stability may thus be assumed adequate.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase I report.

The safety of Clove River Dam is in question because the dam does not have adequate spillway capacity to pass the PMF or even one-half of the PMF without overtopping. Overtopping of the dam carries with it the danger of possible progressive failure of the dam or spillway. The dam's present spillway capacity can pass only about 28 percent of the PMF, and is "inadequate."

No definitive statement pertaining to the safety of the embankment can be made without acquisition of embankment and foundation material engineering properties. However, the dam was properly constructed with a corewall, 2H:1V slopes on the downstream face, and it has rip-rap protection on the upstream face. It is therefore considered, by inspection, to be adequate.

b. Adequacy of Information

The information uncovered was adequate to perform hydrologic and hydraulic computations, although the depth of the lake is not known. The data was insufficient to perform even an approximate computation of the embankment's stability. A preliminary assessment of the embankment could be made by visual observation only.

c. Urgency of Studies

All recommended studies should be conducted by an engineer, experienced in the design and construction of dams.

A more precise hydrologic and hydraulic analysis of the dam should be conducted within six months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop alternative schemes for construction. This should include the installation of headwater and tailwater gages, and determination of the ability of the dam to withstand overtopping.

Observation wells or piezometers should be installed in the downstream embankment to determine the location of the phreatic surface. The borings should be logged according to the Unified Soil Classification system by qualified personnel and samples taken to

determine the values of pertinent soil parameters for stability analyses in accordance with Chapter 4.4 of the Corps Guidelines.

The existing dam drawing should be annotated and updated to form a coherent as-built set within 3 months.

7.2 Remedial Measures

a. Alternatives for Increasing Spillway Capacity

Alternatives for increasing spillway capacity are as follows:

1. Increase the dam and core-wall height, thus permitting a higher discharge to pass over the spillway and reducing the possibility of overtopping.

2. Lower the spillway crest elevation.

3. Increase the effective spillway crest length.

4. A combination of any of the above alternatives.

b. Other Remedial Measures

1. All brush and trees should be removed from the crest and the downstream and upstream slopes to avoid problems which may develop from roots. The embankment faces should then be seeded to develop a growth of grass for surface erosion protection. This program should be started within six months.

2. Repair all cracked and spalled concrete with epoxy cement within six months.

3. Provide slope protection on the right bank of the downstream channel, at the toe of the spillway. This is to be done within six months.

c. Recommendations

The following additional action is recommended.

1. Establish a flood-warning system for the downstream community within three months.

2. Regrade the crest of the embankment to restore vertical alignment above the top of the concrete core wall.

3. Remove the dead trees lying on the downstream channel, and the abandoned farm bridge's concrete abutments and central pier located about 100 yards downstream to prevent clogging with

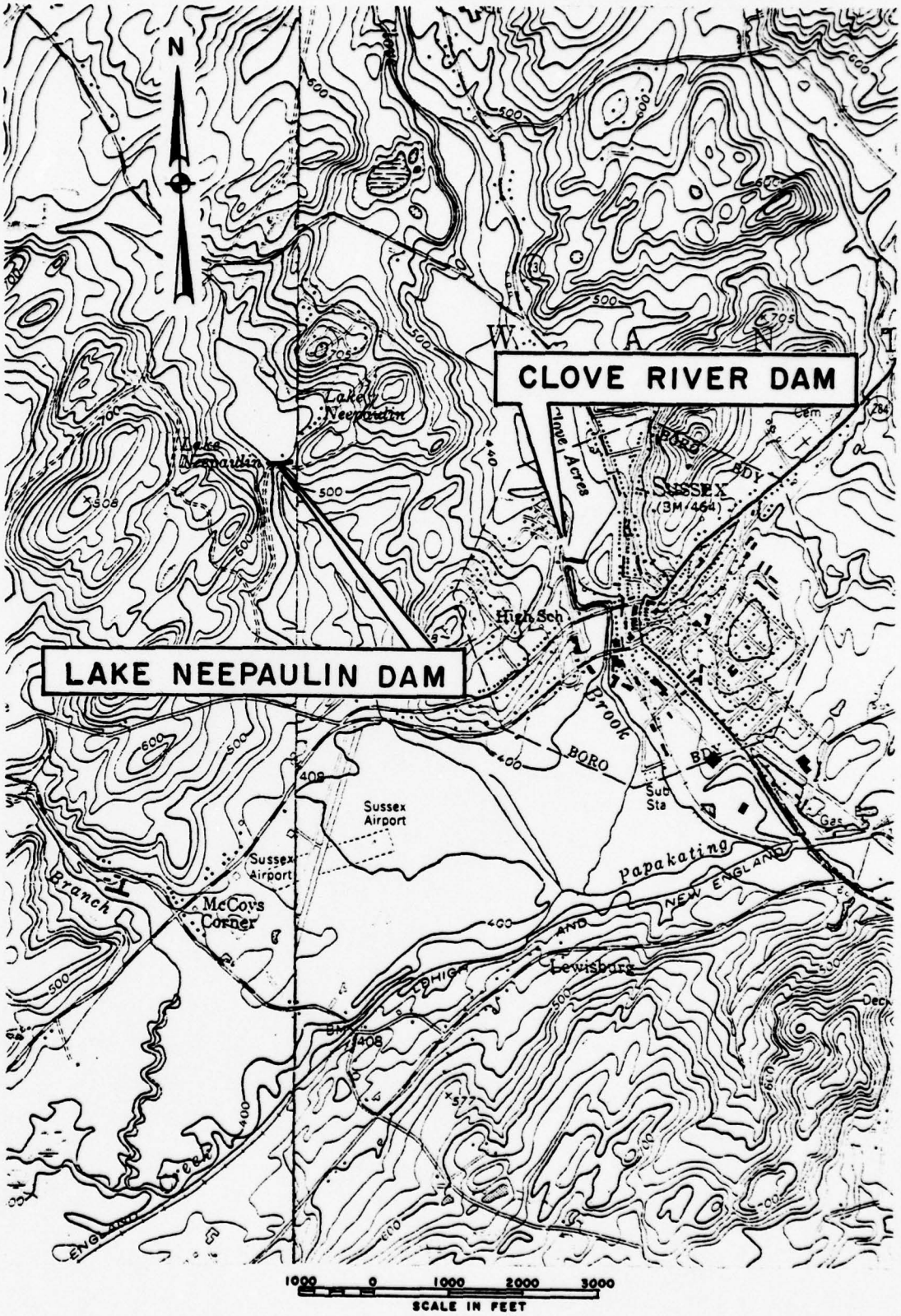
trees and debris during a storm and possible collapse of the pier or abutments, local flooding and bank erosion.

4. Consider providing additional low-level outlet facilities.

d. O & M Procedures

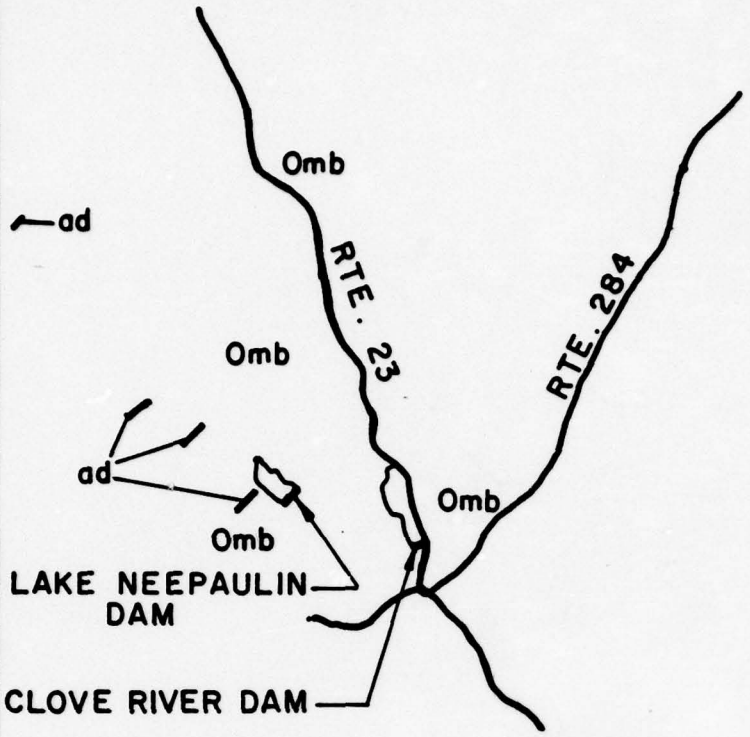
A formalized program of annual inspection of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance and operating events of the dam, the lake and the outlet passages. Movement and settlement of the embankment should be monitored regularly be means of surveying monuments, and any seepage flows recorded.

PLATES



VICINITY MAP

PLATE 1



1 0 1 2

Scale: 1" = 1 Mile

LEGEND

ORDOVICIAN

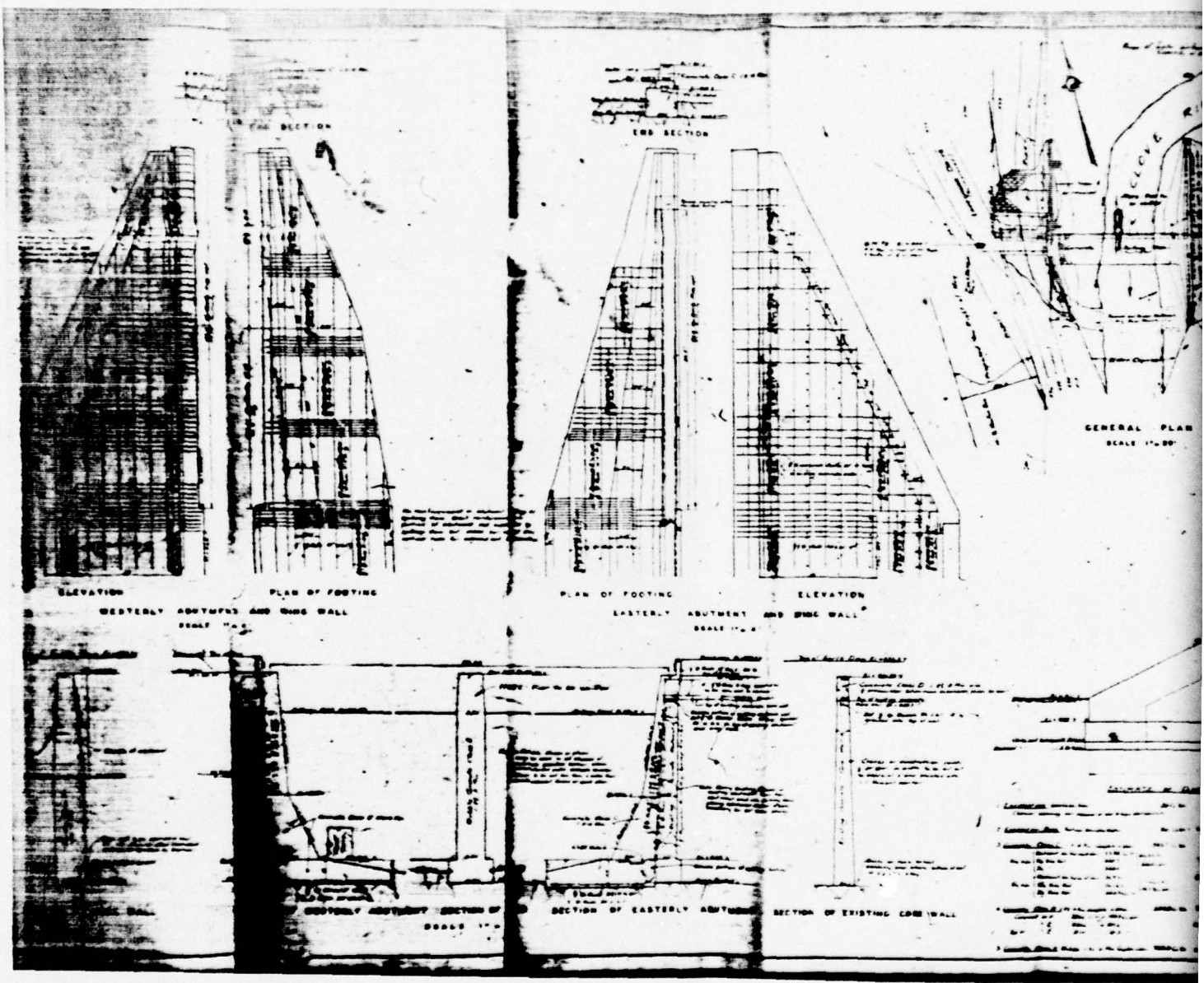
Omb Martinsburg Shale
Black Slaty Shale (Roofing Slate in places) with Thin Beds of Sandstone (Flagstone) Especially in Upper parts.

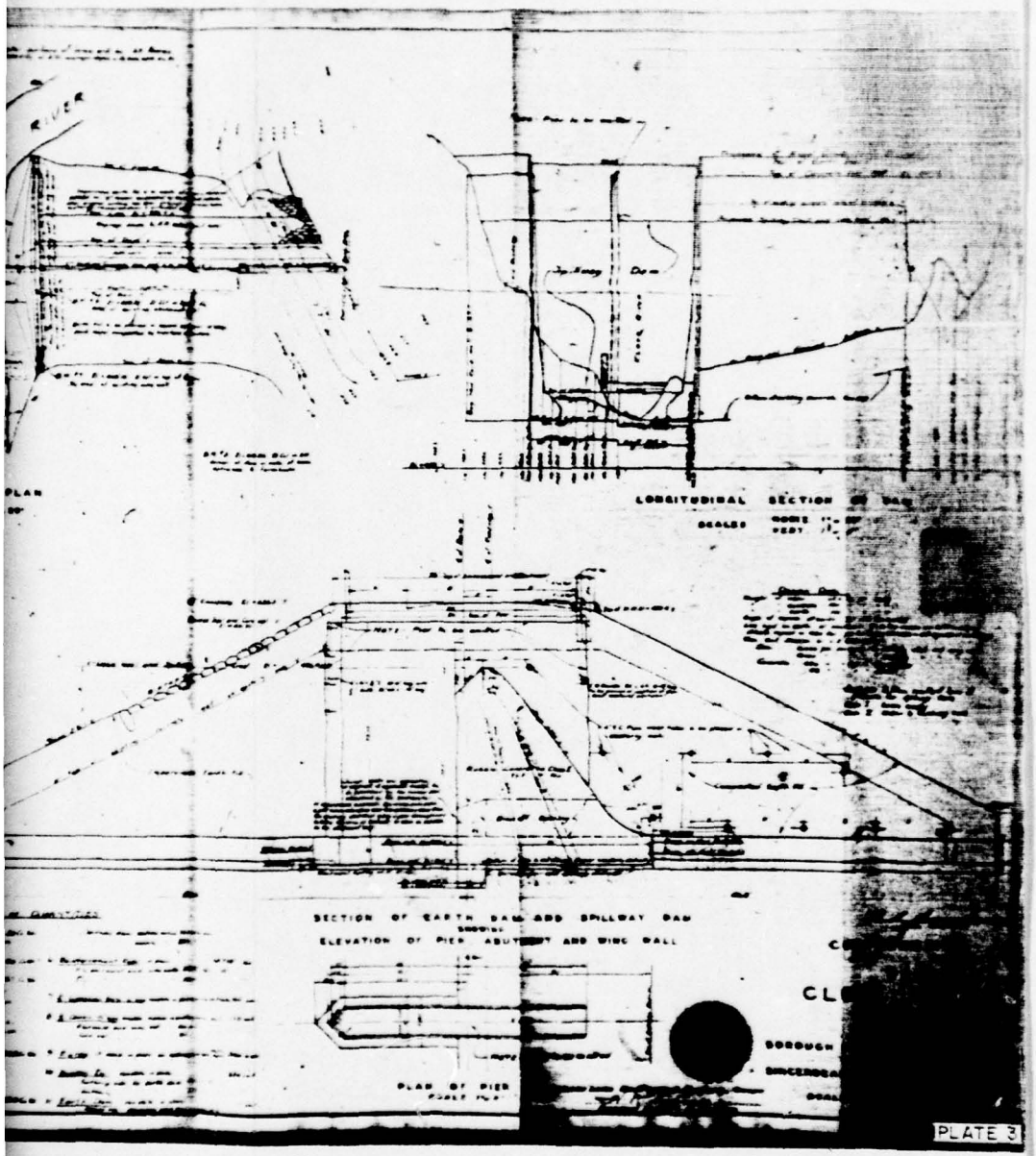
QUATERNARY

ad Stratified Drift (Wisconsin).

GEOLOGIC MAP
LAKE NEEPAULIN DAM & CLOVE RIVER DAM

PLATE 2




RIVER
LONGITUDINAL SECTION
SECTION OF EARTH DAM AND SPILLWAY DAM
ELEVATION OF PIER, ABUTMENT AND WING WALL
PLAN OF PIER
PLATE 3

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION, MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION

PHASE I

Name of Dam Clove River County Sussex State New Jersey Coordinators NJDEP

Date(s) Inspection May 7, 1979 Weather Fair Temperature 70°F

Pool elevation at Time of Inspection 423.2' M.S.L. Tailwater at time of Inspection 406.0' M.S.L.

Inspection Personnel:

Seymour Roth
R. Ernest-Jones
E. Koo
H. King
C. Chin

Owner/Representative:

None attended.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None.	
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	Vertical alignment is good to fair. Horizontal alignment is good.	Regrade crest to correct vertical alignment.
RIPRAP FAILURES	None.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
VEGETATION	Upstream and downstream faces and crest are covered with brush and trees to 10 inch diameter.	Remove trees and brush, and plant grass for erosion protection.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Slight degradation between embankment and spillway wingwalls - used as foot paths from crest to downstream pool. Top of concrete core wall visible on right embankment and on left embankment it is visible near wingwall and left end.	Add quarry-run stone cover to required grade.
ANY NOTICEABLE SEEPAGE	Minor seepage observed on right embankment just downstream of right wingwall, estimated at 1/2 gallon per minute.	No action necessary at this time, because seepage is small and could come from properties on right bank. Keep under periodic observation.
STAFF GAGE AND RECORDER	None.	Provide upstream and downstream gages.
DRAINS	None visible on embankments. Right wingwall of spillway has two levels of weep holes. Those in lower row were discharging water.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Concrete ogee, 81 feet long. Concrete spillway apron lip is flush with surface of bedrock. There are some spalling, cracking, and deposits on surfaces of ogee and wingwalls. There is severe spalling at intersection of spillway and wingwalls (up to 4 inches deep). Flow over crest is smooth.	Repair cracks and spalling with epoxy concrete.
APPROACH CHANNEL	None.	
DISCHARGE CHANNEL	Natural rock bottom with soil banks. Trees growing inwards on both banks. Channel side slopes at 1.5H:1V on both banks.	
BRIDGE AND PIERS	None.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN See spillway.		
INTAKE STRUCTURE None provided.		
OUTLET STRUCTURE None provided.		
OUTLET FACILITIES	3' x 4' opening at lower right corner of spillway, narrows to 3' x 3' at upstream end. Closed by sluice gate having manually operated mechanism that is damaged and inoperable. Operation is from platform (also damaged) above spillway crest.	Rehabilitate entire mechanism and platform.
EMERGENCY GATE None.		

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/SURVEYS		
None.		Install survey monuments and benchmark to monitor vertical and horizontal alignments.
OBSERVATION WELLS		
None.		
WEIRS		
None.		
PIEZOMETERS		
None.		Provide piezometers on downstream face of right embankment to monitor phreatic levels.
OTHERS		
None.		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SLOPES	Moderately sloping, grassed banks. Some homes and commercial establishments along lake shore. Slopes are about 2.5H:1V.	
SEDIMENTATION	Sedimentation in evidence at upstream end of lake; at upstream face of spillway, the sediment is about 5 feet deep.	
USE	Recreational only.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Excellent 40-50 foot wide channel with rocky bottom. Left bank is 8-10 feet high and the right bank is about 25 feet high and supports a busy road at its top. There was some debris at the toe of the spillway, mostly tree trunks. About 100 yards downstream, are the concrete abutments and centerspan pier of a farm bridge, now without a deck.	Remove debris and abandoned bridge supports to prevent clogging with debris in a storm. The stability of the right bank should be investigated.
SLOPES	Side slopes are generally 1.5H:1V. Immediately below spillway, the right bank has eroded and is nearly vertical. Both banks have a fair amount of trees, some leaning inward to the stream. About 5 feet downstream of the right abutment, there is a seepage spot about 18 inches above pool level, estimated at less than 1/2 gallon per minute.	Provide a stable slope and protection on right bank adjacent to toe of spillway, to prevent further scour and possible damage to roadway on top of bank. Investigate seepage.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Immediately downstream are several inhabited buildings (three houses and some farm buildings), and about 250 yards downstream, the channel is crossed by Newton Avenue bridge and Loomis Avenue bridge.	This constitutes a "high" hazard in the event of a dam failure.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	One drawing on microfiche, available at NJDEP, included.
REGIONAL VICINITY MAP	U.S.G.S. Hamburg Quadrangle, New Jersey.
CONSTRUCTION HISTORY	Documents on microfiches, available at NJDEP.
TYPICAL SECTIONS OF DAM	One drawing on microfiche, available at NJDEP.
HYDROLOGIC/HYDRAULIC DATA	Not available.
OUTLETS - PLAN	One drawing, on microfiche, available at NJDEP.
- DETAILS	One drawing, on microfiche, available at NJDEP.
- CONSTRAINTS	Not available.
- DISCHARGE RATINGS	Not available.
RAINFALL/RESERVOIR RECORDS	Not available.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	Not available.
GEOLOGY REPORTS	Not available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Spillway capacity and stability calculations by reviewer in NJDEP, on microfiche at NJDEP.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Field surveys of excavation and fill operations on microfiche at NJDEP.
POST-CONSTRUCTION SURVEYS OF DAM	Survey reports on microfiche, at NJDEP. (1968 survey)
BORROW SOURCES	None given.
SPILLWAY PLAN - SECTIONS	One drawing on microfiche, at NJDEP.
- DETAILS	One drawing on microfiche, at NJDEP.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	See OUTLETS.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	None.
MAINTENANCE OPERATION RECORDS	None.

APPENDIX B

PHOTOGRAPHS

(Taken on May 7, 1979)

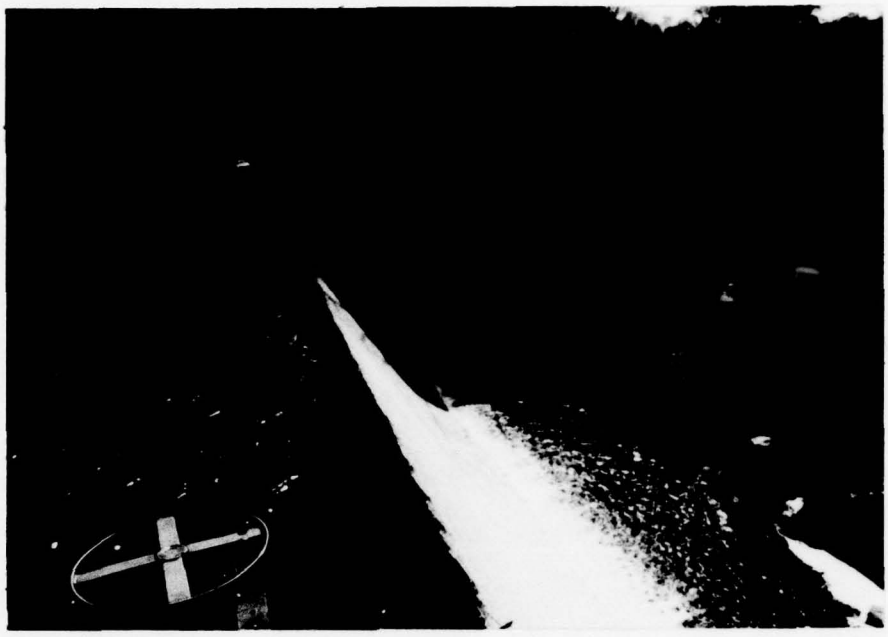


Photo No. 1 - Overall view of spillway showing the left embankment and the farm in the flood path. Note the smooth flow over the ogee, the cracks and laitence in the wingwall, and the exposed corewall.

Photo No. 2 - View of spillway from downstream.

Photo No. 3 - Overall view of upstream side of dam, with the spillway on the right. Note the heavy growth of trees on the upstream face, displacing the rip-rap protection.

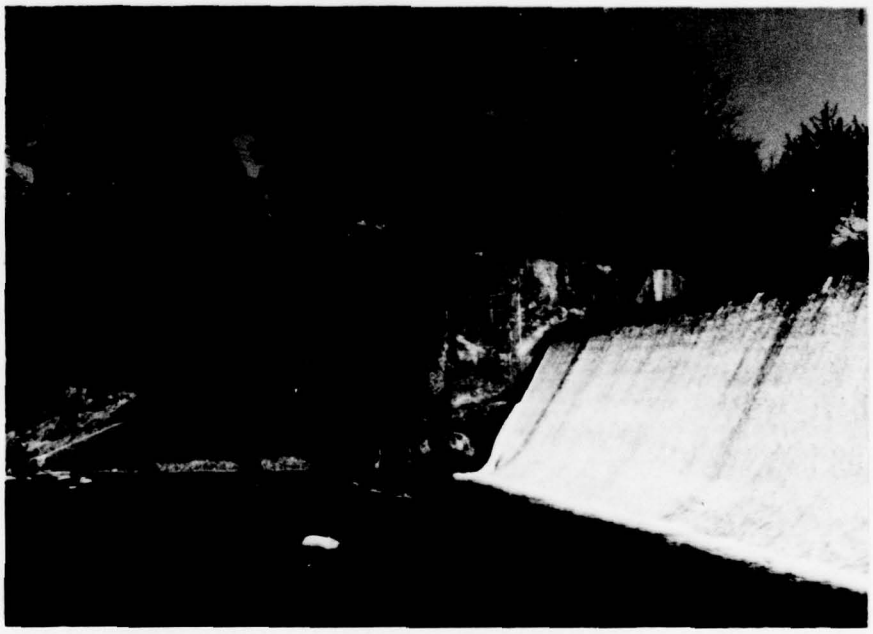


Photo No. 4 - View of right wingwall. Note the seepage from the drains and the minor erosion of concrete at the water-line.

Photo No. 5 - Detail of right wingwall and spillway face showing the surface spalling and seepage. Note also the rectangular outlet in the bottom right corner of the spillway.

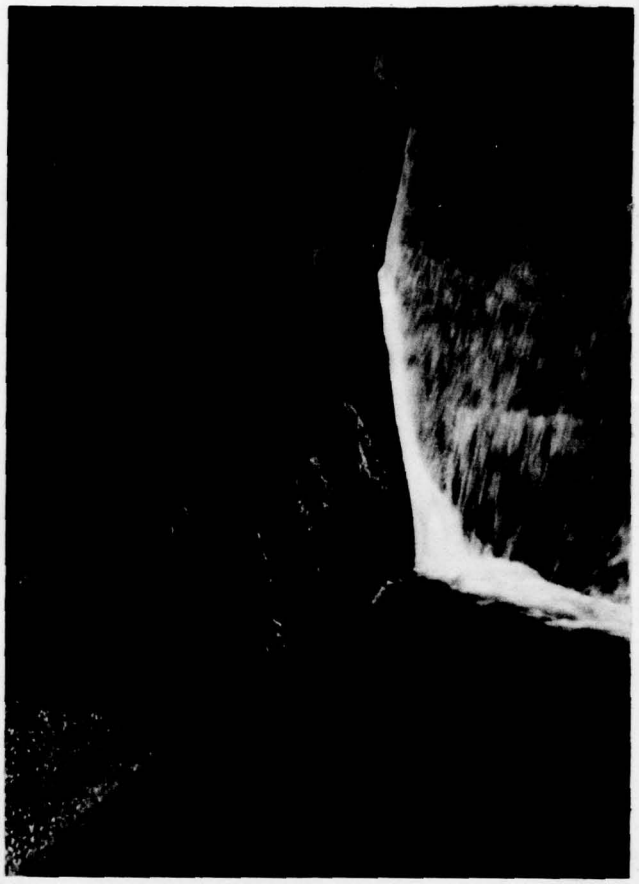


Photo No. 6 - Detail of left wingwall showing the extent of surface spalling and seepage.

Photo No. 7 - Detail of top of left wingwall showing concrete deterioration at a construction joint.

Photo No. 8 - Top of embankment, towards the left side, showing the top of the corewall.

Photo No. 9 - Detail of toe of right wingwall showing minor embankment seepage.

Photo No. 10 - View of dilapidated control apparatus for the low-level outlet. Also shows overall view of Clove Acres Lake.

Photo No. 11 - View of downstream channel showing the old bridge structure from which the deck has been lost.

Photo No. 12 - View of downstream channel where it runs parallel to the road embankment, across the flood plain. Photo shows the three residential properties which are in the most danger from flooding.

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: Clove River

Drainage Area Characteristics: Woodland, with residential development.

Elevation Top Normal Pool (Storage Capacity): 423.2' MSL (133 acre-feet)

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: (SDF) 434.04'MSL (633 acre-feet)

Elevation Top Dam: 431.5' MSL (472 acre-feet)

SPILLWAY CREST

a. Elevation 423.0' MSL

b. Type Dropped concrete ogee.

c. Width 2'

d. Length 81'

e. Location Spillover Full length.

f. No. and Type of Gates None.

OUTLET WORK

a. Type Rectangular culvert. (3' x 4')

b. Location Bottom right corner of spillway.

c. Entrance Inverts 406' MSL (estimate)

d. Exit Inverts 406' MSL (estimate)

e. Emergency Draindown Facilities None.

HYDROMETEOROLOGICAL GAGES

a. Type N/A

b. Location N/A

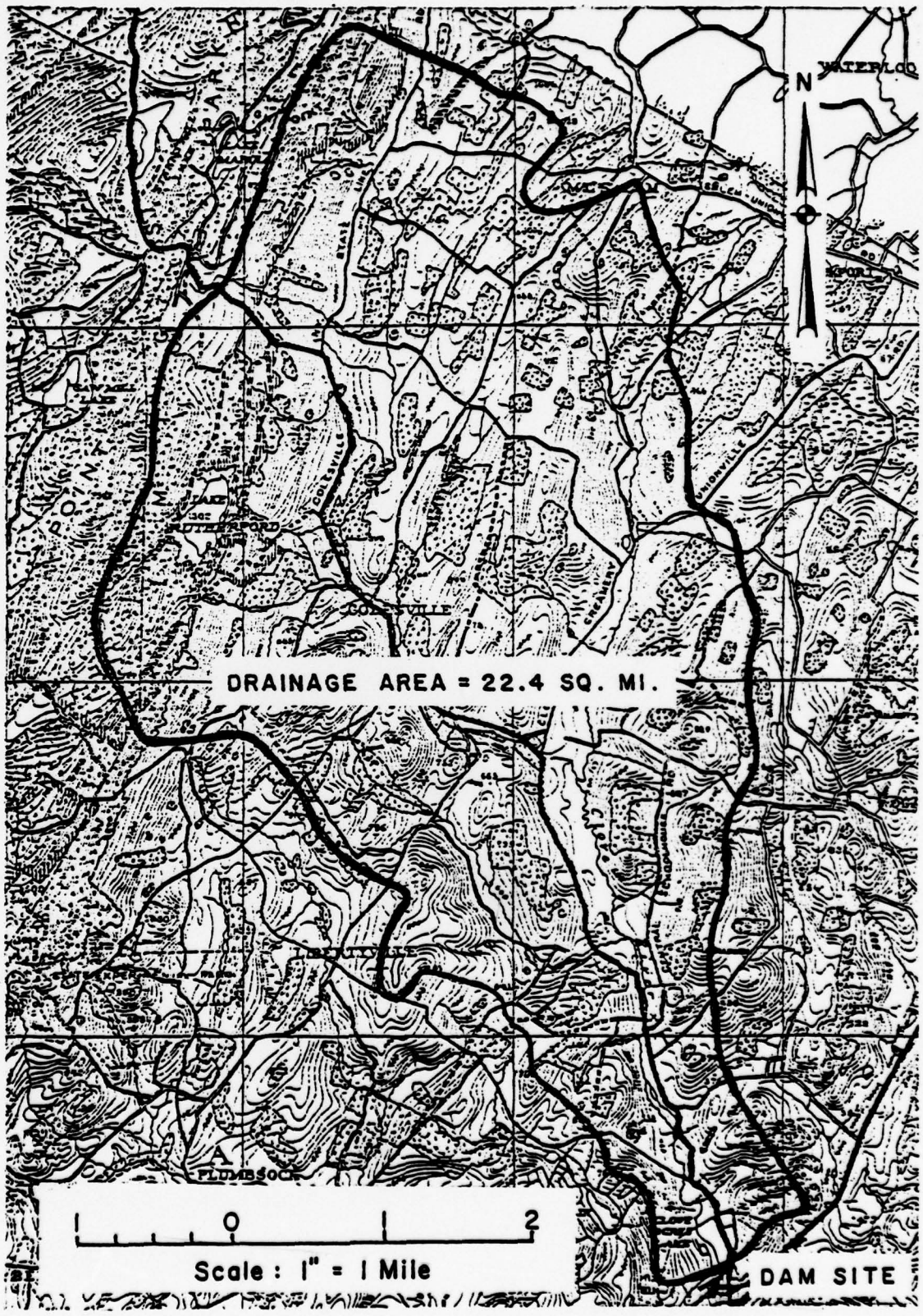
c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE 7,628 cfs

APPENDIX D

HYDROLOGIC COMPUTATIONS

PLATE I APPENDIX D



CLOVE RIVER DAM
DRAINAGE BASIN

Hazard Classification : "HIGH"

Clove River Dam is classified in the Dam size category as being 'small' since its storage is less than 1000 AF and its height is less than 40 ft.

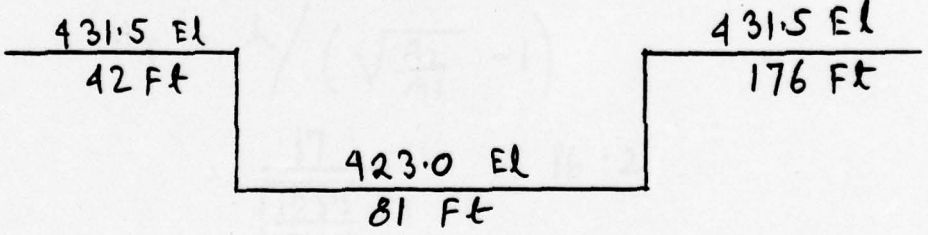
$$SDF = \frac{1}{2}PMF$$

Hydrologic analysis

D.A = 22.4 sq mile

Inflow Hydrograph at Reservoir was determined using HEC1 DB program. Inflow routed through reservoir.

Spillway and Dam

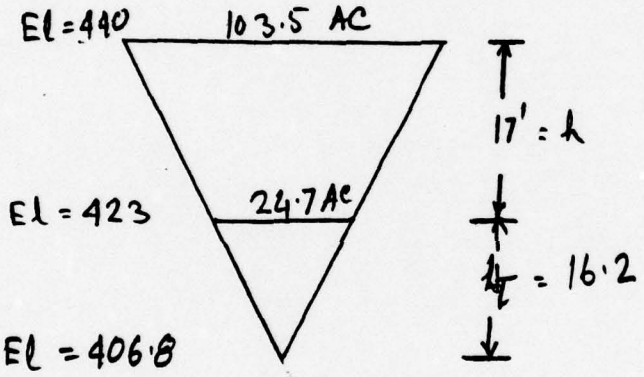


Low level outlet :-

The low level outlet is a 3'×3' Conduit - leading to a 48"×36" inch outlet. The sluice gate is not operable due to long standing neglect. However a drawdown calculation is made at the end.

Reservoir stage area relations

Elevation	Area in Acres
+406.8	0
423 (Pool)	24.7 Ac
440	103.5 Ac



$$H_T = h \Big/ \left(\sqrt{\frac{A_2}{A_1}} - 1\right)$$

$$= \frac{17}{\sqrt{\frac{103.5}{24.7}} - 1} = 16.2$$

* Estimated value.

Determination of PMP

PMP amount from HMS Report 33
= 22" (200 sq mile - 24 hrs all season envelope)

Depth area duration relationship Percentage to be applied to the above figure (D.A = 22.4 sq. miles).

ZONE 6

6 hr.	=	106 %
12 hr	=	114 %
24 hr	=	124 %
48 hrs	=	134 %

Infiltration Data

Using "Engineering soil survey of N.J, Rutgers University January, 1954"

Soil Classification	HS.G	% D.A	CN	
SA - 2g c	B	25	80	20
SA - 2 lg	C	25	85	21.25
GM-24 / SH ge	B	60	61	36
			Avg CN	77

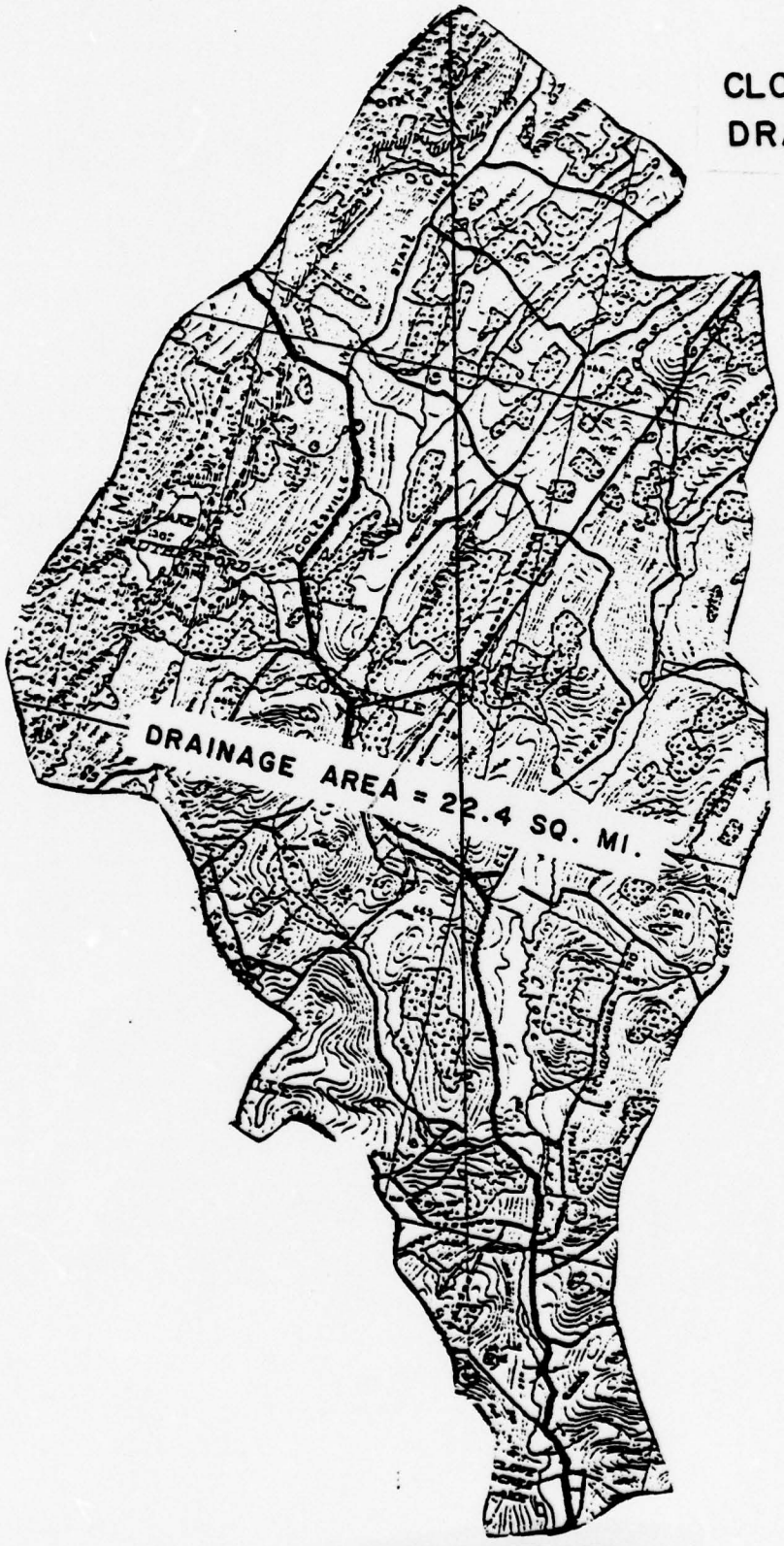
$S = \frac{1000}{CN} - 10 = 2.99$ $I_a = .2\,S = .6$ IN

CN for a saturated Condition = 90 (SCS Handbook 10-7)
Using Fig 10-1 infiltration rate = .02 in/hr

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N. J. Dam Inspection
Clove Lake Dam
COMPUTED BY S.B CHECKED BY
SHEET NO. 4 OF
JOB NO. 10-A20-01
DATE Aug., 1979

CLOVE RIVER DAM DRAINAGE BASIN



L = 8.0 Miles
Lc = 5.0 Miles

L = Length of stream

L_{CA} = River Mileage from station to the opposite of C.G of D.A

For U.H.G.

Snyders Coefficient assumed

$C_p = 0.62$

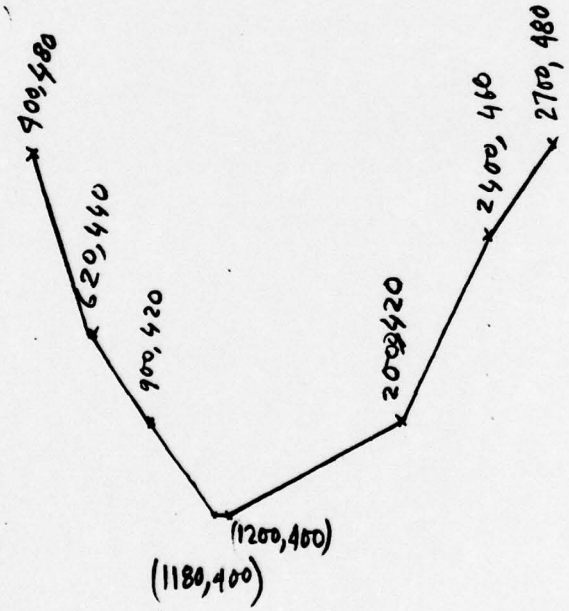
$C_t = 2.0$

$t_p = C_t (L\,Lc)^{0.3}$

$= 2.0 (8 \times 5)^{0.3}$

$= 6.05$ hrs.

Cross Section at D/S Reach



$S = \frac{20}{7200} = .00278$

Cross section of reach 1 at 1600 ft D/S of Dam.

FREDERIC R. HARRIS, INC.
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SUBJECT N.J. Dam Inspection
Clove Lake Dam
COMPUTED BY S.B CHECKED BY

SHEET NO. 6 OF
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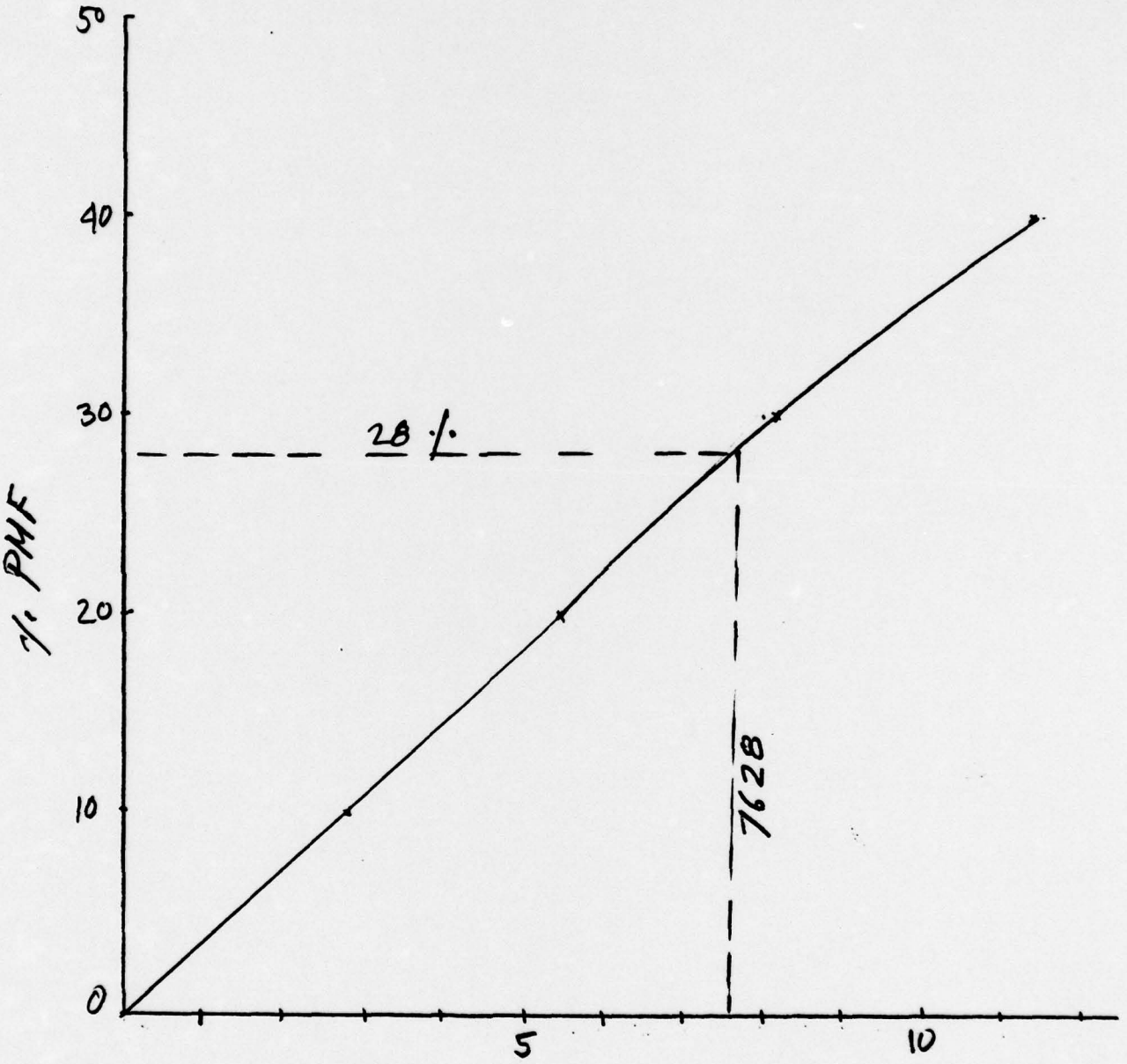
DATE Aug., 1979

Overtopping Potential



Overtopping of Dam occurs at EL 431.5

Q = 7628 (28 % of PMF)

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N.J. Dam Inspection
Clove Lake Dam
COMPUTED BY S.B. CHECKED BY

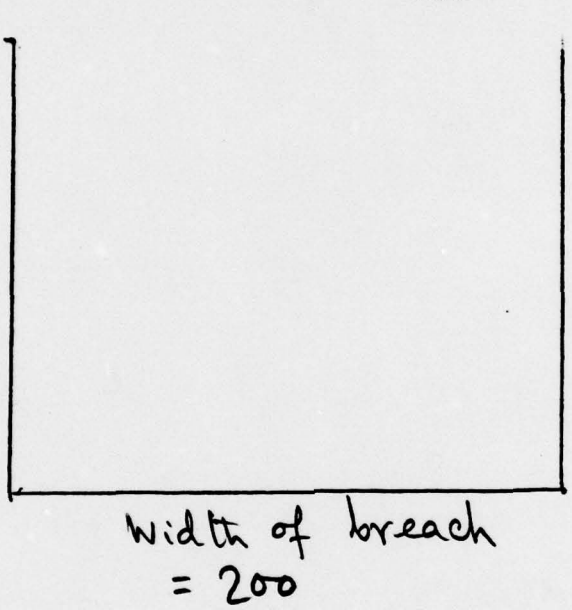
SHEET NO. 7 OF
JOB NO. 10-A20-01
DATE Aug 1971

Overtopping Over the Dam

% PMF	Q	Max WSEl	Max Feet above Dam	Duration of Flooding	Max WSEl 1600 ft 3/5
10	2722	427.28	0	0	405.2
20	5444	429.79	0	0	406.9
30	8187	431.83	.33	2.50	408.2
40	10958	433.05	1.55	5.25	409.1
50	13704	434.04	2.54	6.00	410.0

Breach Analysis

Assume breach begins to develop when reservoir stage reaches just above the Dam. Assumed elevation 432 (+), 0.5 ft above the dam



Effect of breach was analysed 1,600 ft D/s of Dam

Max. W.S EL without Dam Break = 410.0

Max WSEL with Dam Break = 410.6

There will be no appreciable increase in stage due to Dam break.

Reservoir Evaluation

a) Discharge Vs head

Low level outlet area = $3 \times 3 = 9$ sq ft

Tailwater elevation assumed

$408 + 2 = 410$ Ft

Inlet loss coeff = 0.12
Exit loss = 1.0

$$K_f = \frac{29.1\, n^2 L}{R^{4/3}} = \frac{29.1 \times (.015)^2 \times 18}{\left(\frac{12}{14}\right)^{1.333}} \approx 0.15$$

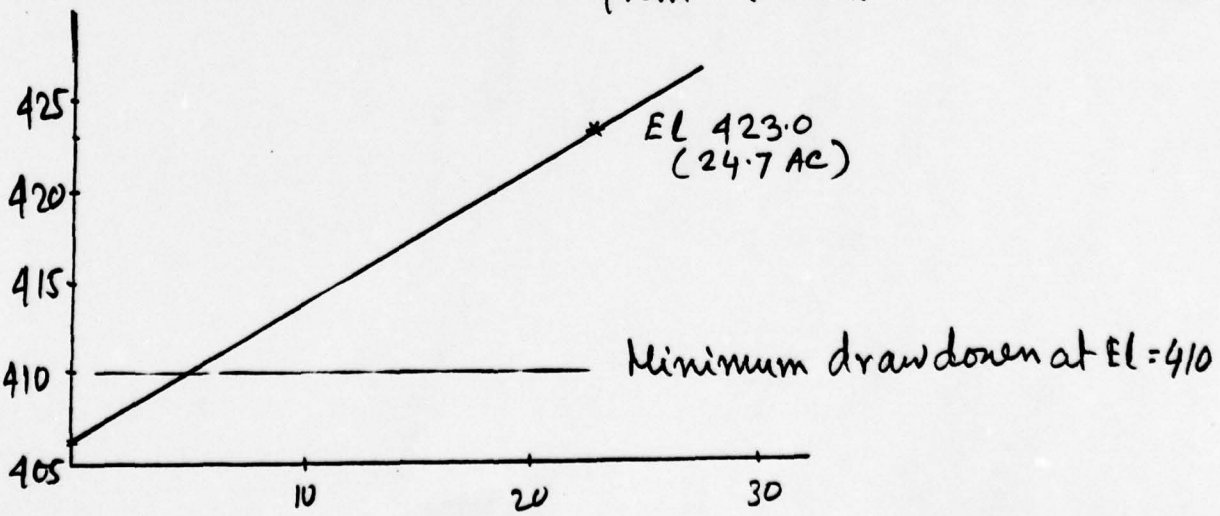
$$\Sigma K = 1.27$$

$$Q = A\sqrt{29\, H/K}$$

$$= 9\sqrt{\frac{64.9 \times H}{1.27}}$$

$$= 64\sqrt{H}$$

b) Area Vs. Head : Assume st. line relationship from normal W.S to stream bed



c) Drainage Area = 22.4 sq Mile
Inflow = 2 cfs / sq mile = 44.8 cfs

El	Area AC	Av Area (Ac)	Vol (AF)	Head on outlet H	Outlet Q=64√H	Time to draw $t_1 = \frac{Vol \times 24}{1.98 Q}$ (hrs)	Time to draw 44.8 cfs $\frac{44.8 \times t_1}{Q}$ t_2 (hrs)	Total time $t_1 + t_2$
423	24.7							
		23.17	46.35	12	222	2.53	.51	3.04
421	21.65							
		20.12	40.25	10	202	2.41	.53	2.94
419	18.60							
		17.08	34.15	8	181	2.28	.56	2.84
417	15.55							
		14.02	28.05	6	157	2.16	.62	2.78
415	12.50							
		10.98	21.95	4	128	2.07	.72	2.79
413	9.45							
		7.93	15.85	2	91	2.11	1.03	3.14
411	6.40							
		5.64	11.28	.5	45	3.03	3.02	6.05
410	4.88							
						16.59		23.58

Time of drawdown with no inflow.
= 16.6 hrs

Time of drawdown with Const. inflow of 2 cfs/SM
= 24 hrs ≈ 1 day

HEC1-DB

COMPUTER PRINT-OUT

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                A1       N.J. DAM INSPECTION
    2                A2       CLOVE LAKE DAM
    3                A3       MULTIRATIO PMF ROUTING
    4                B    100        0       15        0        0        0        0        0        0        0
    5                B1     5
    6                J      1        5        1
    7                J1    .5       .4       .3       .2       .1
    8                K      0      RES                                      1
    9                K1       LOCAL INFLOW TO RES.
   10                M      1        1     22.4                22.4
   11                P      0       22      106      114      124      134
   12                T                                                  .6      .02
   13                W   6.05      .62
   14                X     -1     -.05        2
   15                K      1      DAM                                      1
   16                K1       ROUTED THROUGH DAM
   17                Y                                        1        1
   18                Y1     1                                                -423
   19                SA     0     24.7    103.5
   20                SE 406.8      423      440
   21                SS   423       81      3.8      1.5
   22                SD 431.5     2.75      1.5      218
   23                K      1    REACH                                      1
   24                K1       CHANNEL ROUTING BY MOD. PULLS
   25                Y                                 1        1
   26                Y1     1
   27                Y6    .1      .05       .1      400      430     1600   .00278
   28                Y7   400      480      620      440      900      420     1180      400     1200      400
   29                Y7  2000      420     2400      460     2700      480
   30                K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

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RUNOFF HYDROGRAPH AT          RES
ROUTE HYDROGRAPH TO           DAM
ROUTE HYDROGRAPH TO         REACH
END OF NETWORK
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

 RUN  DATE= 79/08/07.
      TIME= 14.25.58.


                    N.J. DAM INSPECTION
                    CLOVE LAKE DAM
                    MULTIRATIO PMF ROUTING

                                JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
         100        0       15        0        0        0        0        0        0        0
                                   JOPER      NWT   LROPT    TRACE
                                       5        0        0        0


                              MULTI-PLAN ANALYSES TO BE PERFORMED
                                        NPLAN= 1 NRTIO= 5 LRTIO= 1
                    RTIOS=     .50      .40      .30      .20      .10


**********      **********      **********      **********      **********

                              SUB-AREA RUNOFF COMPUTATION

                    LOCAL INFLOW TO RES.

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                            RES       0       0       0       0       0       1       0       0

                                    HYDROGRAPH DATA
                IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                    1       1   22.40    0.00   22.40    0.00   0.000       0       0       0

                                      PRECIP DATA
                         SPFE     PMS      R6     R12     R24     R48     R72     R96
                         0.00   22.00  106.00  114.00  124.00  134.00    0.00    0.00
 TRSPC COMPUTED BY THE PROGRAM IS  .827

                                      LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00     .60     .02    0.00    0.00

                                  UNIT HYDROGRAPH DATA
                              TP=  6.05    CP= .62    NTA=  0

                                  RECESSION DATA
                              STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=26.14 AND R=22.75 INTERVALS

      UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=   6.01 HOURS, CP=  .62  VOL=  .98
        13.     50.    103.    166.    238.    316.    399.    486.    577.    670.
       766.    864.    963.   1062.   1154.   1236.   1308.   1371.   1425.   1469.
      1503.   1528.   1542.   1545.   1536.   1511.   1462.   1399.   1339.   1282.
      1226.   1174.   1123.   1075.   1029.    984.    942.    902.    863.    826.
       790.    756.    724.    692.    663.    634.    607.    581.    556.    532.
       509.    487.    466.    446.    427.    409.    391.    374.    358.    343.
       328.    314.    300.    287.    275.    263.    252.    241.    231.    221.
```

		211.	202.	193.	185.	177.	170.	162.	155.	147.	142.			
		136.	130.	125.	119.	114.	109.	105.	100.	96.	92.			
		88.	84.	80.	77.	74.	70.	67.	64.	62.	59.			
	0					END-OF-PERIOD FLOW								
MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	
1.01	.15	1	.00	0.00	.00	21.	1.02	.15	97	.03	.03	.01	1154.	
1.01	.30	2	.00	0.00	.00	20.	1.02	.30	98	.03	.03	.01	1107.	
1.01	.45	3	.00	0.00	.00	18.	1.02	.45	99	.03	.03	.01	1062.	
1.01	1.00	4	.00	0.00	.00	17.	1.02	1.00	100	.03	.03	.01	1021.	
1.01	1.15	5	.00	0.00	.00	16.	0.00	0.00	101	.03	.03	.01	983.	
1.01	1.30	6	.00	0.00	.00	15.	0.00	0.00	102	.03	.03	.01	949.	
1.01	1.45	7	.00	0.00	.00	14.	0.00	0.00	103	.03	.03	.01	920.	
1.01	2.00	8	.00	0.00	.00	13.	0.00	0.00	104	.03	.03	.01	894.	
1.01	2.15	9	.00	0.00	.00	12.	0.00	0.00	105	.03	.03	.01	872.	
1.01	2.30	10	.00	0.00	.00	11.	0.00	0.00	106	.03	.03	.01	854.	
1.01	2.45	11	.00	0.00	.00	10.	0.00	0.00	107	.03	.03	.01	840.	
1.01	3.00	12	.00	0.00	.00	10.	0.00	0.00	108	.03	.03	.01	830.	
1.01	3.15	13	.00	0.00	.00	9.	0.00	0.00	109	.03	.03	.01	823.	
1.01	3.30	14	.00	0.00	.00	8.	0.00	0.00	110	.03	.03	.01	821.	
1.01	3.45	15	.00	0.00	.00	8.	0.00	0.00	111	.03	.03	.01	822.	
1.01	4.00	16	.00	0.00	.00	7.	0.00	0.00	112	.03	.03	.01	826.	
1.01	4.15	17	.00	0.00	.00	7.	0.00	0.00	113	.03	.03	.01	834.	
1.01	4.30	18	.00	0.00	.00	6.	0.00	0.00	114	.03	.03	.01	844.	
1.01	4.45	19	.00	0.00	.00	6.	0.00	0.00	115	.03	.03	.01	857.	
1.01	5.00	20	.00	0.00	.00	6.	0.00	0.00	116	.03	.03	.01	871.	
1.01	5.15	21	.00	0.00	.00	5.	0.00	0.00	117	.03	.03	.01	888.	
1.01	5.30	22	.00	0.00	.00	5.	0.00	0.00	118	.03	.03	.01	906.	
1.01	5.45	23	.00	0.00	.00	5.	0.00	0.00	119	.03	.03	.01	925.	
1.01	6.00	24	.00	0.00	.00	4.	0.00	0.00	120	.03	.03	.01	945.	
1.01	6.15	25	.00	0.00	.00	4.	0.00	0.00	121	.06	.06	.01	966.	
1.01	6.30	26	.00	0.00	.00	4.	0.00	0.00	122	.06	.06	.01	989.	
1.01	6.45	27	.00	0.00	.00	3.	0.00	0.00	123	.06	.06	.01	1012.	
1.01	7.00	28	.00	0.00	.00	3.	0.00	0.00	124	.06	.06	.01	1037.	
1.01	7.15	29	.00	0.00	.00	3.	0.00	0.00	125	.06	.06	.01	1063.	
1.01	7.30	30	.00	0.00	.00	3.	0.00	0.00	126	.06	.06	.01	1091.	
1.01	7.45	31	.00	0.00	.00	3.	0.00	0.00	127	.06	.06	.01	1120.	
1.01	8.00	32	.00	0.00	.00	2.	0.00	0.00	128	.06	.06	.01	1151.	
1.01	8.15	33	.00	0.00	.00	2.	0.00	0.00	129	.06	.06	.01	1184.	
1.01	8.30	34	.00	0.00	.00	2.	0.00	0.00	130	.06	.06	.01	1220.	
1.01	8.45	35	.00	0.00	.00	2.	0.00	0.00	131	.06	.06	.01	1257.	
1.01	9.00	36	.00	0.00	.00	2.	0.00	0.00	132	.06	.06	.01	1297.	
1.01	9.15	37	.00	0.00	.00	2.	0.00	0.00	133	.06	.06	.01	1339.	
1.01	9.30	38	.00	0.00	.00	2.	0.00	0.00	134	.06	.06	.01	1384.	
1.01	9.45	39	.00	0.00	.00	2.	0.00	0.00	135	.06	.06	.01	1431.	
1.01	10.00	40	.00	0.00	.00	1.	0.00	0.00	136	.06	.06	.01	1480.	
1.01	10.15	41	.00	0.00	.00	1.	0.00	0.00	137	.06	.06	.01	1531.	
1.01	10.30	42	.00	0.00	.00	1.	0.00	0.00	138	.06	.06	.01	1583.	
1.01	10.45	43	.00	0.00	.00	1.	0.00	0.00	139	.06	.06	.01	1636.	
1.01	11.00	44	.00	0.00	.00	1.	0.00	0.00	140	.06	.06	.01	1691.	
1.01	11.15	45	.00	0.00	.00	1.	0.00	0.00	141	.06	.06	.01	1745.	
1.01	11.30	46	.00	0.00	.00	1.	0.00	0.00	142	.06	.06	.01	1801.	
1.01	11.45	47	.00	0.00	.00	1.	0.00	0.00	143	.06	.06	.01	1856.	
1.01	12.00	48	.00	0.00	.00	1.	0.00	0.00	144	.06	.06	.01	1911.	
1.01	12.15	49	.04	0.00	.04	1.	0.00	0.00	145	.48	.48	.01	1971.	
1.01	12.30	50	.04	0.00	.04	1.	0.00	0.00	146	.48	.48	.01	2045.	
1.01	12.45	51	.04	0.00	.04	1.	0.00	0.00	147	.48	.48	.01	2140.	
1.01	13.00	52	.04	0.00	.04	1.	0.00	0.00	148	.48	.48	.01	2259.	
1.01	13.15	53	.05	0.00	.05	1.	0.00	0.00	149	.58	.57	.01	2408.	
1.01	13.30	54	.05	0.00	.05	1.	0.00	0.00	150	.58	.57	.01	2591.	
1.01	13.45	55	.05	0.00	.05	0.	0.00	0.00	151	.58	.57	.01	2812.	
1.01	14.00	56	.05	0.00	.05	0.	0.00	0.00	152	.58	.57	.01	3074.	
1.01	14.15	57	.06	0.00	.06	0.	0.00	0.00	153	.72	.72	.01	3381.	
1.01	14.30	58	.06	.03	.03	1.	0.00	0.00	154	.72	.72	.01	3739.	
1.01	14.45	59	.06	.05	.01	3.	0.00	0.00	155	.72	.72	.01	4151.	

1.01	15.00	60	.06	.05	.01	7.	0.00	0.00	156	.72	.72	.01	4620.
1.01	15.15	61	.06	.05	.01	14.	0.00	0.00	157	.73	.73	.01	5150.
1.01	15.30	62	.12	.11	.01	26.	0.00	0.00	158	1.47	1.46	.01	5747.
1.01	15.45	63	.33	.33	.01	47.	0.00	0.00	159	4.10	4.10	.01	6464.
1.01	16.00	64	.08	.08	.01	80.	0.00	0.00	160	1.03	1.02	.01	7332.
1.01	16.15	65	.05	.05	.01	123.	0.00	0.00	161	.67	.67	.01	8322.
1.01	16.30	66	.05	.05	.01	175.	0.00	0.00	162	.67	.67	.01	9402.
1.01	16.45	67	.05	.05	.01	234.	0.00	0.00	163	.67	.67	.01	10547.
1.01	17.00	68	.05	.05	.01	300.	0.00	0.00	164	.67	.67	.01	11770.
1.01	17.15	69	.04	.04	.01	373.	0.00	0.00	165	.53	.53	.01	13047.
1.01	17.30	70	.04	.04	.01	451.	0.00	0.00	166	.53	.53	.01	14363.
1.01	17.45	71	.04	.04	.01	536.	0.00	0.00	167	.53	.53	.01	15705.
1.01	18.00	72	.04	.04	.01	625.	0.00	0.00	168	.53	.53	.01	17064.
1.01	18.15	73	.00	0.00	.00	718.	0.00	0.00	169	.05	.04	.01	18422.
1.01	18.30	74	.00	0.00	.00	813.	0.00	0.00	170	.05	.04	.01	19755.
1.01	18.45	75	.00	0.00	.00	908.	0.00	0.00	171	.05	.04	.01	21038.
1.01	19.00	76	.00	0.00	.00	1003.	0.00	0.00	172	.05	.04	.01	22245.
1.01	19.15	77	.00	0.00	.00	1093.	0.00	0.00	173	.05	.04	.01	23349.
1.01	19.30	78	.00	0.00	.00	1177.	0.00	0.00	174	.05	.04	.01	24331.
1.01	19.45	79	.00	0.00	.00	1255.	0.00	0.00	175	.05	.04	.01	25185.
1.01	20.00	80	.00	0.00	.00	1326.	0.00	0.00	176	.05	.04	.01	25909.
1.01	20.15	81	.00	0.00	.00	1389.	0.00	0.00	177	.05	.04	.01	26500.
1.01	20.30	82	.00	0.00	.00	1443.	0.00	0.00	178	.05	.04	.01	26956.
1.01	20.45	83	.00	0.00	.00	1489.	0.00	0.00	179	.05	.04	.01	27275.
1.01	21.00	84	.00	0.00	.00	1523.	0.00	0.00	180	.05	.04	.01	27455.
1.01	21.15	85	.00	0.00	.00	1546.	0.00	0.00	181	.05	.04	.01	27496.
1.01	21.30	86	.00	0.00	.00	1558.	0.00	0.00	182	.05	.04	.01	27399.
1.01	21.45	87	.00	0.00	.00	1557.	0.00	0.00	183	.05	.04	.01	27161.
1.01	22.00	88	.00	0.00	.00	1544.	0.00	0.00	184	.05	.04	.01	26773.
1.01	22.15	89	.00	0.00	.00	1517.	0.00	0.00	185	.05	.04	.01	26225.
1.01	22.30	90	.00	0.00	.00	1481.	0.00	0.00	186	.05	.04	.01	25568.
1.01	22.45	91	.00	0.00	.00	1440.	0.00	0.00	187	.05	.04	.01	24865.
1.01	23.00	92	.00	0.00	.00	1396.	0.00	0.00	188	.05	.04	.01	24131.
1.01	23.15	93	.00	0.00	.00	1350.	0.00	0.00	189	.05	.04	.01	23373.
1.01	23.30	94	.00	0.00	.00	1302.	0.00	0.00	190	.05	.04	.01	22599.
1.01	23.45	95	.00	0.00	.00	1253.	0.00	0.00	191	.05	.04	.01	21816.
1.02	0.00	96	.00	0.00	.00	1204.	0.00	0.00	192	.05	.04	.01	21034.
									SUM	24.37	23.13	1.24	836174.
										(619.)	(587.)	(32.)	(23677.81)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	27496.	24370.	8247.	4300.	825643.
CMS	779.	690.	234.	122.	23380.
INCHES		10.12	13.70	14.29	14.29
MM		257.06	347.94	362.88	362.88
AC-FT		12084.	16357.	17059.	17059.
THOUS CU M		14906.	20176.	21042.	21042.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .40	RATIO 3 .30	RATIO 4 .20	RATIO 5 .10
HYDROGRAPH AT	HES	22.40	1	13748.	10998.	8249.	5499.	2750.
		(58.02)		(389.30)(	311.44)(	233.58)(	155.72)(	77.86)(
ROUTED TO	DAM	22.40	1	13704.	10958.	8187.	5444.	2722.
		(58.02)		(388.05)(	310.29)(	231.83)(	154.17)(	77.07)(
ROUTED TO	REACH	22.40	1	13700.	10952.	8189.	5443.	2721.
		(58.02)		(387.93)(	310.12)(	231.88)(	154.13)(	77.04)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	423.00	423.00	431.50
STORAGE	133.	133.	472.
OUTFLOW	0.	0.	7628.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	434.04	2.54	633.	13704.	6.00	45.50	0.00
.40	433.05	1.55	567.	10958.	5.25	45.50	0.00
.30	431.83	.33	492.	8187.	2.50	45.50	0.00
.20	429.79	0.00	381.	5444.	0.00	45.75	0.00
.10	427.28	0.00	269.	2722.	0.00	45.75	0.00

PLAN 1 STATION REACH

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	13700.	410.0	45.50
.40	10952.	409.1	45.50
.30	8189.	408.2	45.75
.20	5443.	406.9	45.75
.10	2721.	405.2	45.75

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
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     1              A1       N.J. DAM INSPECTION
     2              A2       CLOVE LAKE DAM
     3              A3       DAM BREAK ANALYSIS
     4              B   100        0       15        0        0        0        0        0        0        0
     5              B1    5
     6              J     1        1        1
     7              J1   .5
     8              K     0      RES                                                    1
     9              K1       LOCAL INFLOW TO RES.
    10              M     1        1     22.4                22.4
    11              P     0       22      106      114      124      134
    12              T                                                          .6      .02
    13              W  6.05      .62
    14              X    -1     -.05        2
    15              K     1      DAM                                                    1
    16              K1       ROUTED THROUGH DAM
    17              Y                                          1        1
    18              Y1    1                                                       -423
    19              SA    0     24.7    103.5
    20              SE 406.8      423      440
    21              SS   423       81      3.8      1.5
    22              SD 431.5     2.75      1.5      218
    23              SB   200        0      420        1      423      432
    24              K     1    REACH                                                  1
    25              K1       CHANNEL ROUTING BY MOD. PULLS
    26              Y                                          1        1
    27              Y1    1
    28              Y6   .1       .05       .1      400      430     1600   .00278
    29              Y7   400      480      620      440      900      420     1180      400     1200      400
    30              Y7  2000      420     2400      460     2700      480
    31              K*    99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULAT

RUNOFF HYDROGRAPH AT	RES
ROUTE HYDROGRAPH TO	DAM
ROUTE HYDROGRAPH TO	REACH
END OF NETWORK	

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

RUN DATE= 79/08/07.
TIME= 14.59.56.

N.J. DAM INSPECTION
CLOVE LAKE DAM
DAM BREAK ANALYSIS

JOB SPECIFICATION

NO	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= .50

SUB-AREA RUNOFF COMPUTATION

LOCAL INFLOW TO RES.

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
RES	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	22.40	0.00	22.40	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	106.00	114.00	124.00	134.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .827

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.60	.02	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 6.05 CP= .62 NTA= 0

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=26.14 AND R=22.75 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 6.01 HOURS, CP= .62 VOL= .98

13.	50.	103.	166.	238.	316.	399.	486.	577.	670.
766.	864.	963.	1062.	1154.	1236.	1308.	1371.	1425.	1469.
1503.	1528.	1542.	1545.	1536.	1511.	1462.	1399.	1339.	1282.
1226.	1174.	1123.	1075.	1029.	984.	942.	902.	863.	826.
790.	756.	724.	692.	663.	634.	607.	581.	556.	532.
509.	487.	466.	446.	427.	409.	391.	374.	358.	343.
328.	314.	300.	287.	275.	263.	252.	241.	231.	221.

		211.	202.	193.	185.	177.	170.	162.	155.	149.	142.				
		136.	130.	125.	119.	114.	109.	105.	100.	96.	92.				
		88.	84.	80.	77.	74.	70.	67.	64.	62.	59.				
0						END-OF-PERIOD FLOW									
MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q		
1.01	.15	1	.00	0.00	.00	21.	1.02	.15	97	.03	.03	.01	1154.		
1.01	.30	2	.00	0.00	.00	20.	1.02	.30	98	.03	.03	.01	1107.		
1.01	.45	3	.00	0.00	.00	18.	1.02	.45	99	.03	.03	.01	1062.		
1.01	1.00	4	.00	0.00	.00	17.	1.02	1.00	100	.03	.03	.01	1021.		
1.01	1.15	5	.00	0.00	.00	16.	0.00	0.00	101	.03	.03	.01	983.		
1.01	1.30	6	.00	0.00	.00	15.	0.00	0.00	102	.03	.03	.01	949.		
1.01	1.45	7	.00	0.00	.00	14.	0.00	0.00	103	.03	.03	.01	920.		
1.01	2.00	8	.00	0.00	.00	13.	0.00	0.00	104	.03	.03	.01	894.		
1.01	2.15	9	.00	0.00	.00	12.	0.00	0.00	105	.03	.03	.01	872.		
1.01	2.30	10	.00	0.00	.00	11.	0.00	0.00	106	.03	.03	.01	854.		
1.01	2.45	11	.00	0.00	.00	10.	0.00	0.00	107	.03	.03	.01	840.		
1.01	3.00	12	.00	0.00	.00	10.	0.00	0.00	108	.03	.03	.01	830.		
1.01	3.15	13	.00	0.00	.00	9.	0.00	0.00	109	.03	.03	.01	823.		
1.01	3.30	14	.00	0.00	.00	8.	0.00	0.00	110	.03	.03	.01	821.		
1.01	3.45	15	.00	0.00	.00	8.	0.00	0.00	111	.03	.03	.01	822.		
1.01	4.00	16	.00	0.00	.00	7.	0.00	0.00	112	.03	.03	.01	826.		
1.01	4.15	17	.00	0.00	.00	7.	0.00	0.00	113	.03	.03	.01	834.		
1.01	4.30	18	.00	0.00	.00	6.	0.00	0.00	114	.03	.03	.01	844.		
1.01	4.45	19	.00	0.00	.00	6.	0.00	0.00	115	.03	.03	.01	857.		
1.01	5.00	20	.00	0.00	.00	6.	0.00	0.00	116	.03	.03	.01	871.		
1.01	5.15	21	.00	0.00	.00	5.	0.00	0.00	117	.03	.03	.01	888.		
1.01	5.30	22	.00	0.00	.00	5.	0.00	0.00	118	.03	.03	.01	906.		
1.01	5.45	23	.00	0.00	.00	5.	0.00	0.00	119	.03	.03	.01	925.		
1.01	6.00	24	.00	0.00	.00	4.	0.00	0.00	120	.03	.03	.01	945.		
1.01	6.15	25	.00	0.00	.00	4.	0.00	0.00	121	.06	.06	.01	966.		
1.01	6.30	26	.00	0.00	.00	4.	0.00	0.00	122	.06	.06	.01	989.		
1.01	6.45	27	.00	0.00	.00	3.	0.00	0.00	123	.06	.06	.01	1012.		
1.01	7.00	28	.00	0.00	.00	3.	0.00	0.00	124	.06	.06	.01	1037.		
1.01	7.15	29	.00	0.00	.00	3.	0.00	0.00	125	.06	.06	.01	1063.		
1.01	7.30	30	.00	0.00	.00	3.	0.00	0.00	126	.06	.06	.01	1091.		
1.01	7.45	31	.00	0.00	.00	3.	0.00	0.00	127	.06	.06	.01	1120.		
1.01	8.00	32	.00	0.00	.00	2.	0.00	0.00	128	.06	.06	.01	1151.		
1.01	8.15	33	.00	0.00	.00	2.	0.00	0.00	129	.06	.06	.01	1184.		
1.01	8.30	34	.00	0.00	.00	2.	0.00	0.00	130	.06	.06	.01	1220.		
1.01	8.45	35	.00	0.00	.00	2.	0.00	0.00	131	.06	.06	.01	1257.		
1.01	9.00	36	.00	0.00	.00	2.	0.00	0.00	132	.06	.06	.01	1297.		
1.01	9.15	37	.00	0.00	.00	2.	0.00	0.00	133	.06	.06	.01	1339.		
1.01	9.30	38	.00	0.00	.00	2.	0.00	0.00	134	.06	.06	.01	1384.		
1.01	9.45	39	.00	0.00	.00	2.	0.00	0.00	135	.06	.06	.01	1431.		
1.01	10.00	40	.00	0.00	.00	1.	0.00	0.00	136	.06	.06	.01	1480.		
1.01	10.15	41	.00	0.00	.00	1.	0.00	0.00	137	.06	.06	.01	1531.		
1.01	10.30	42	.00	0.00	.00	1.	0.00	0.00	138	.06	.06	.01	1583.		
1.01	10.45	43	.00	0.00	.00	1.	0.00	0.00	139	.06	.06	.01	1636.		
1.01	11.00	44	.00	0.00	.00	1.	0.00	0.00	140	.06	.06	.01	1691.		
1.01	11.15	45	.00	0.00	.00	1.	0.00	0.00	141	.06	.06	.01	1745.		
1.01	11.30	46	.00	0.00	.00	1.	0.00	0.00	142	.06	.06	.01	1801.		
1.01	11.45	47	.00	0.00	.00	1.	0.00	0.00	143	.06	.06	.01	1856.		
1.01	12.00	48	.00	0.00	.00	1.	0.00	0.00	144	.06	.06	.01	1911.		
1.01	12.15	49	.04	0.00	.04	1.	0.00	0.00	145	.48	.48	.01	1971.		
1.01	12.30	50	.04	0.00	.04	1.	0.00	0.00	146	.48	.48	.01	2045.		
1.01	12.45	51	.04	0.00	.04	1.	0.00	0.00	147	.48	.48	.01	2140.		
1.01	13.00	52	.04	0.00	.04	1.	0.00	0.00	148	.48	.48	.01	2259.		
1.01	13.15	53	.05	0.00	.05	1.	0.00	0.00	149	.58	.57	.01	2408.		
1.01	13.30	54	.05	0.00	.05	1.	0.00	0.00	150	.58	.57	.01	2591.		
1.01	13.45	55	.05	0.00	.05	0.	0.00	0.00	151	.58	.57	.01	2812.		
1.01	14.00	56	.05	0.00	.05	0.	0.00	0.00	152	.58	.57	.01	3074.		
1.01	14.15	57	.06	0.00	.06	0.	0.00	0.00	153	.72	.72	.01	3381.		
1.01	14.30	58	.06	.03	.03	1.	0.00	0.00	154	.72	.72	.01	3739.		
1.01	14.45	59	.06	.05	.01	3.	0.00	0.00	155	.72	.72	.01	4151.		

1.01	15.00	60	.06	.05	.01	14.	0.00	0.00	157	.73	.73	.01	5150.
1.01	15.15	61	.06	.05	.01	14.	0.00	0.00	157	.73	.73	.01	5150.
1.01	15.30	62	.12	.11	.01	26.	0.00	0.00	158	1.47	1.46	.01	5747.
1.01	15.45	63	.33	.33	.01	47.	0.00	0.00	159	4.10	4.10	.01	6464.
1.01	16.00	64	.08	.08	.01	80.	0.00	0.00	160	1.03	1.02	.01	7332.
1.01	16.15	65	.05	.05	.01	123.	0.00	0.00	161	.67	.67	.01	8322.
1.01	16.30	66	.05	.05	.01	175.	0.00	0.00	162	.67	.67	.01	9402.
1.01	16.45	67	.05	.05	.01	234.	0.00	0.00	163	.67	.67	.01	10547.
1.01	17.00	68	.05	.05	.01	300.	0.00	0.00	164	.67	.67	.01	11770.
1.01	17.15	69	.04	.04	.01	373.	0.00	0.00	165	.53	.53	.01	13047.
1.01	17.30	70	.04	.04	.01	451.	0.00	0.00	166	.53	.53	.01	14363.
1.01	17.45	71	.04	.04	.01	536.	0.00	0.00	167	.53	.53	.01	15705.
1.01	18.00	72	.04	.04	.01	625.	0.00	0.00	168	.53	.53	.01	17064.
1.01	18.15	73	.00	0.00	.00	718.	0.00	0.00	169	.05	.04	.01	18422.
1.01	18.30	74	.00	0.00	.00	813.	0.00	0.00	170	.05	.04	.01	19755.
1.01	18.45	75	.00	0.00	.00	908.	0.00	0.00	171	.05	.04	.01	21038.
1.01	19.00	76	.00	0.00	.00	1003.	0.00	0.00	172	.05	.04	.01	22245.
1.01	19.15	77	.00	0.00	.00	1093.	0.00	0.00	173	.05	.04	.01	23349.
1.01	19.30	78	.00	0.00	.00	1177.	0.00	0.00	174	.05	.04	.01	24331.
1.01	19.45	79	.00	0.00	.00	1255.	0.00	0.00	175	.05	.04	.01	25185.
1.01	20.00	80	.00	0.00	.00	1326.	0.00	0.00	176	.05	.04	.01	25909.
1.01	20.15	81	.00	0.00	.00	1389.	0.00	0.00	177	.05	.04	.01	26500.
1.01	20.30	82	.00	0.00	.00	1443.	0.00	0.00	178	.05	.04	.01	26956.
1.01	20.45	83	.00	0.00	.00	1489.	0.00	0.00	179	.05	.04	.01	27275.
1.01	21.00	84	.00	0.00	.00	1523.	0.00	0.00	180	.05	.04	.01	27455.
1.01	21.15	85	.00	0.00	.00	1546.	0.00	0.00	181	.05	.04	.01	27496.
1.01	21.30	86	.00	0.00	.00	1558.	0.00	0.00	182	.05	.04	.01	27399.
1.01	21.45	87	.00	0.00	.00	1557.	0.00	0.00	183	.05	.04	.01	27161.
1.01	22.00	88	.00	0.00	.00	1544.	0.00	0.00	184	.05	.04	.01	26773.
1.01	22.15	89	.00	0.00	.00	1517.	0.00	0.00	185	.05	.04	.01	26225.
1.01	22.30	90	.00	0.00	.00	1481.	0.00	0.00	186	.05	.04	.01	25568.
1.01	22.45	91	.00	0.00	.00	1440.	0.00	0.00	187	.05	.04	.01	24865.
1.01	23.00	92	.00	0.00	.00	1396.	0.00	0.00	188	.05	.04	.01	24131.
1.01	23.15	93	.00	0.00	.00	1350.	0.00	0.00	189	.05	.04	.01	23373.
1.01	23.30	94	.00	0.00	.00	1302.	0.00	0.00	190	.05	.04	.01	22599.
1.01	23.45	95	.00	0.00	.00	1253.	0.00	0.00	191	.05	.04	.01	21816.
1.02	0.00	96	.00	0.00	.00	1204.	0.00	0.00	192	.05	.04	.01	21034.
									SUM	24.37	23.13	1.24	836174.
										(619.)	(587.)	(32.)	(23677.81)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	27496.	24370.	8247.	4300.	825643.
CMS	779.	690.	234.	122.	23380.
INCHES		10.12	13.70	14.29	14.29
MM		257.06	347.94	362.88	362.88
AC-FT		12084.	16357.	17059.	17059.
THOUS CU M		14906.	20176.	21042.	21042.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1
				.50
HYDROGRAPH AT	RES	22.40	1	13748.
		(58.02)		(389.30)(
ROUTED TO	DAM	22.40	1	16140.
		(58.02)		(457.04)(
ROUTED TO	REACH	22.40	1	16064.
		(58.02)		(454.89)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	423.00	423.00	431.50
STORAGE	133.	133.	472.
OUTFLOW	0.	0.	7628.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	432.15	.65	511.	16140.	.87	43.50	42.50

PLAN 1 STATION REACH

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	16064.	410.6	43.50